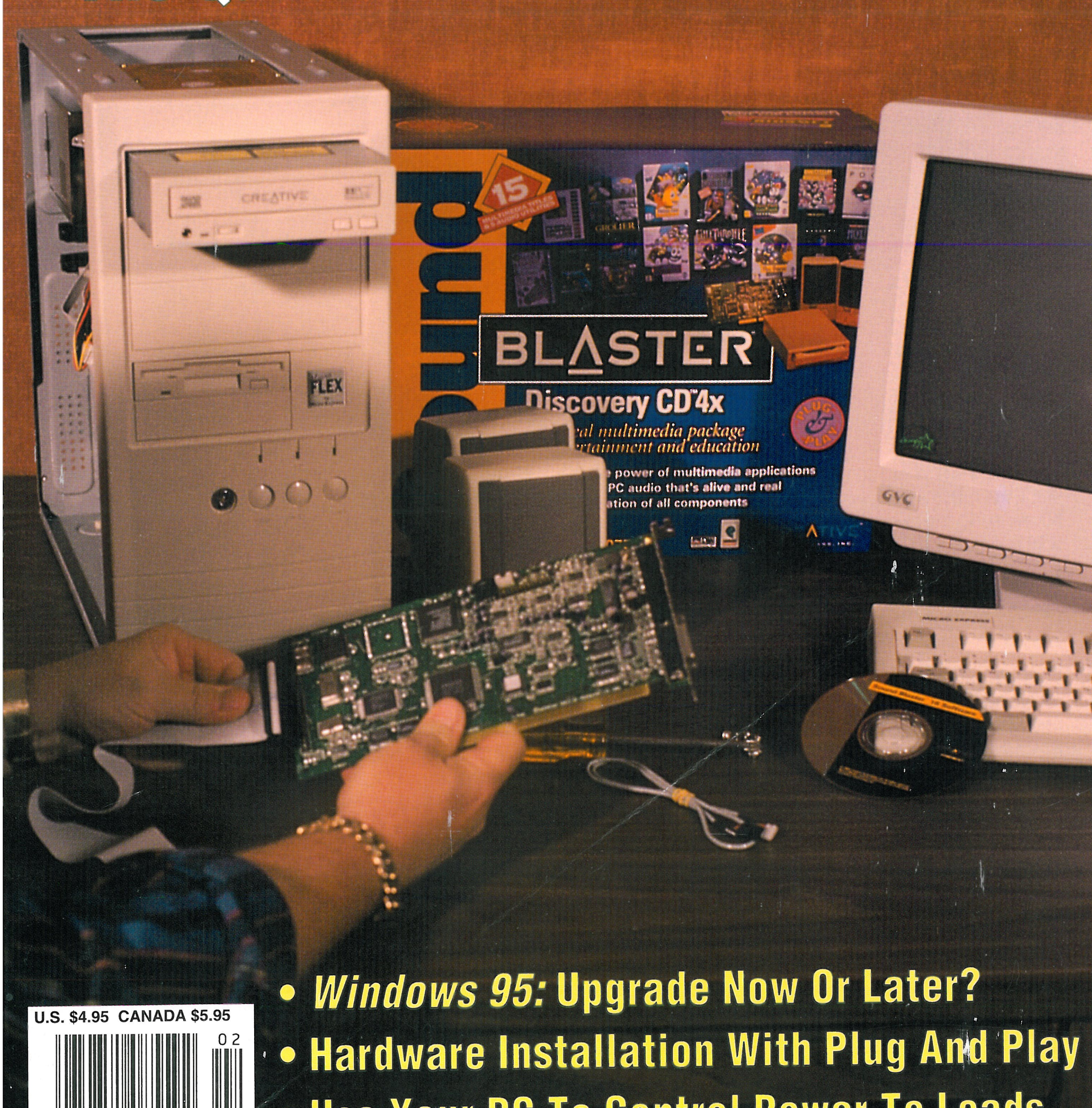
MicroComputer JOURNAL

The print forum for the MicroComputer professional and semi-professional

January/February 1996

The Quest For Multimedia Nirvana



- *Windows 95:* Upgrade Now Or Later?
- Hardware Installation With Plug And Play
- Use Your PC To Control Power To Loads

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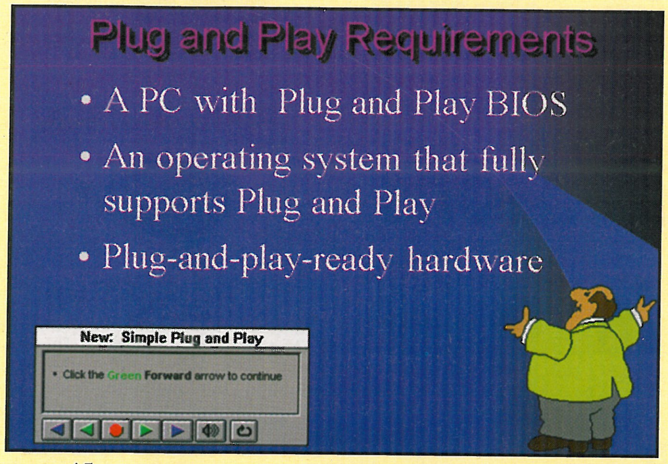
MicroComputer JOURNAL

Volume 3, No. 1, January/February 1996



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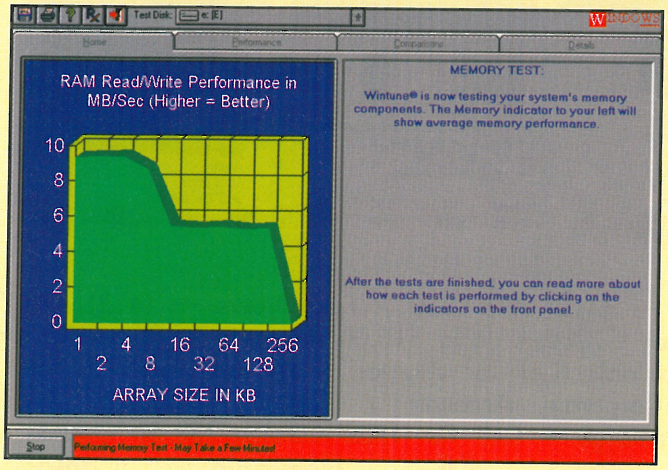

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Features

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In This Issue

Just a few years ago, multimedia was an expensive dream for most personal-computer users. Now, almost every personal computer shipping from dealers comes multimedia-ready, with hardly any increase in cost. If you haven't joined the multimedia revolution but are planning to do so in the near future, Tom Benford tells you what you need to know to proceed in an educated manner in his "Upgrading: The Quest for Multimedia Nirvana" article beginning on page 30.

By now, you've almost certainly heard and read all sorts of hyperbole (and a lot of negatives) about Microsoft's often-delayed *Windows 95* operating system and are wondering if it's the environment for your personal computing now and in the foreseeable future. If you're still sitting on the fence regarding upgrading to *Windows 95*, you'll want to read TJ Byers' "*Windows 95*: Upgrade Now or Later?" beginning on page 45. In this article, TJ addresses such issues as what's new in *Windows 95*, what you should know before upgrading, understanding the *Windows 95* interface, compatibility with existing software and more. Also included are capsule reviews of *Windows 95* tutorials designed to help get you comfortable with this new operating environment.

In "Computer-Controlled Power Switching" beginning on page 14, Jan Axelson serves up a bevy of items you can use to switch power to electrical loads. Then on page 21, Tom Fox details how you can build a simple low-cost, minimum-chip microcontroller in Part 2 of his "A 68HCx11 EEPROM Programmer/Mini-Development System."

For the hardware enthusiast, this issue offers two serial- and one parallel-port-related articles. Greg Young tells you how to use an RS-485 port as an RS-232 port in "RS-485 in a Pinch" on page 51. Next, Duane M. Perkins tells you what you need to know to increase communicating distance in a cable-connected system and offers an RS-232-to-RS-422/485 converter project for you to build in "Getting to Know the RS-422/485 Standard" on page 54. Then on page 59, Paul Bergsman describes A/D converter projects that let you effortlessly "Acquire 12- and 16-Bit Data From a Parallel Printer Port."

If you've ever installed hardware in a PC and have run into problems that have had you pulling your hair, you'll be happy to know that Plug and Play installation is here now. Before you rush out to purchase Plug and Play products, you'll want to read Hardin Brother's "Plug and Play" article beginning on page 70 to find out why it may soon be the answer to your hardware-installation woes.

Closing out the Features section of this issue, Ramon De La Cuetara describes a "Programmable Dual Four-Position Switch" on page 77 that allows a PC to control switching of up to four audio, video or other low-voltage/low-current sources.

Cover Photo By Tom Benford

Wishing You a Happy New Year!

Editorial By Art Salsberg

Around The Corner

The way time flies, almost everything that's expected to happen is just around the corner. This is especially true in the computer field, where life cycles are comparable to that of insects.

Coming up on the fast track, only four years from now, looms the end of the century. Now that won't be the end of the world, just moving into the year 2000. In computer land, however, this unstoppable movement can be a crisis of sorts. Our calendar/time setup doesn't take a century change into consideration. The logic is all wrong in its present state.

Date input, for example, is typically in numeric form as MM-DD-YY (for example, 02-05-95). Many programs were set up to interpret 00 as an earlier year than 99, others are different. Leap years are different, too, (year 2000 is a leap year).

Many of you may think that you've got plenty of time to get a fix on this problem. You may not if you use a financial projection program for retirement purposes. Going beyond four years is commonplace. For financial and insurance businesses, not correcting this problem will be catastrophic. Automatic date foul-ups can generate a foreclosure notice on your home.... So check out your application programs to see if there's a fix for this problem. Also, check your operating system. There are a number of professional support groups to help you here. Check out their charges. One group that specializes in this calendar/date problem is TransCentury Data Systems (tel.: 800-837-7989).

Around the corner, too, are computer temptations that'll face us in '96. As Intel revs up its P6 microprocessor production and increases speeds, it will continue to lower prices of Pentium chips. A Pentium Pro is in the offing to allow PCs to compete with workstations. But from what I hear, they're very slow on the draw for older programs.

There's no doubt that owners of 386-based machines will sense the inadequacies of their computers more strongly as the months pass by, fanned by *Win95* capabilities and upgraded software for it. To realize the exciting capabilities of later software, they'll surely succumb to Pentium fever if the extra bucks are there and a pressing need exits, whether it's multimedia, graphics or what-have-you. Owners of 486-based machines may wait awhile before taking the plunge, as they play a wait-and-see game.

Telecommunications will be bigger than ever in '96 and beyond. It's on a roll. On-line services like America Online, CompuServe, Prodigy, GEnie and the Microsoft Network all offer World Wide Web services now. Expect to see Internet Web Surfers swell its ranks further (there are now some 24-million users over 16 years of age in North America). The report, based on a survey from Commerce New study by Nielsen Media Research, also indicates that 5-million people used the Internet within the study's past 24 hours, among which 2-million downloaded software.

The foregoing action will spur sales of faster machines and speedier modems. There's nothing worse than sitting in front of your video monitor waiting interminably for data to generate and finally display it on-screen...unless it's the telephone bills that are greatly amplified as a result of such delays.

Other changes are brewing around the corner, naturally. Some are more subtle. For instance, Intel plans to build a $1.6-billion manufacturing plant in Israel to produce flash memory devices. To me, this means that flash memory will be designed onto more equipment than ever before. By the time you turn the corner—five years?—you'll likely have a tough time finding EPROMs, except in niche categories. With flash memory coming down in price and its re-programmability function versus EPROM's write-once limitation, flash is the future.

Also around the corner, you'll see motherboard form factors change, called the ATX by Intel. It's an open specification with no license fee. It resembles a baby AT, though it's said to be smaller, less expensive and thermally cooler. The CPU will be moved closer to the power supply, while floppy and IDC connectors will be closer to peripheral bays. There'll be a single 20-pin power connector, including 5, 12 and optional 3 volts and a side powered fan for cooling the CPU. A raft of other improvements and options will be present, including mounting holes that support backward-compatibility with the Baby AT. There'll also be a mini-ATX board.

So keep your eyes peeled for what's coming around the corner. You may be pleasantly surprised. Happy New Year!

Art Salsberg

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Fix Any PC...FAST!

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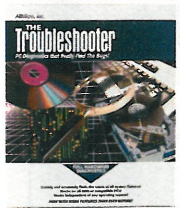

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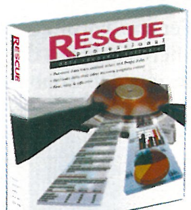

RESCUE Data Recovery Software™ is the only program to easily recover lost data from crashed floppies & hard drives even when DOS can't read them! RESCUE recovers data other recovery programs cannot. RESCUE automatically recovers DOS & Windows files including data from compressed drives. Be prepared for any problem. RESCUE is the insurance and security you need to safeguard your valuable data. Call now! Don't wait until your data is lost!

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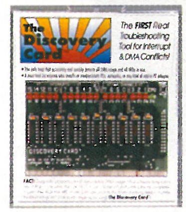
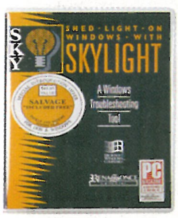


The Discovery Card™ is the first tool to accurately resolve any IRQ or DMA conflict. 18 L.E.D. lights (11 for all interrupts and 7 for all DMA) immediately report actual usage thus saving time when configuring, upgrading or debugging PC's. Software alone cannot detect DMA usage and is often wrong when reporting IRQ conflicts! Call now, save time and end the frustration! *Winner 1995 Top Diagnostic Tool - Windows Magazine*

WINDOWS MAGAZINE 1995 WIN 100

#1 WINDOWS TROUBLESHOOTING TOOL!



Skylight™ is the #1 rated Windows diagnostic (PC Magazine) that tunes optimizes & troubleshoots Windows for maximum speed and performance. Edits all .INI files safely. Graphically displays how Windows is using memory, system resources, system metrics, G.D.I. heap usage plus much more with hundreds of reports! A must for all Windows users! Call now for full list of features!

PC MAGAZINE EDITORS' CHOICE

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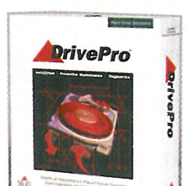

DrivePro™ provides fast, precise installation and maintenance for any hard drive. Override BIOS limitations for user-definable drive types. DOS format any size hard drive in under 30 seconds. IDE drives can be installed in less than 60 seconds. Allows the use of IDE drives with MFM/RLL or ESDI drives in the same system. Retrieves the manufacturers' recommended specs from the drive itself, plus much more! Call now for full list of features!

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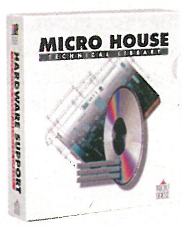

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CIRCLE NO. 101 ON FREE INFORMATION CARD

Hardware

Decoder Ring

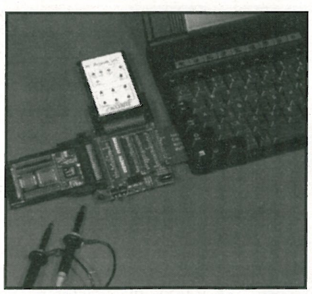
The digital Decoder Ring from Dallas Semiconductor employs an embedded memory chip that communicates directly with a PC to authenticate the wearer as its owner. The ring also supplies a secret encryption key to decode data files in

a PC without requiring lengthy passwords to be entered from the keyboard. The ring is based on the company's patented Touch Memory Button technology. $59.50. *Dallas Semiconductor, 4401 S. Beltwood Pkwy., Dallas, TX 75244; tel.: 214-450-0448; fax: 214-450-3715*

CIRCLE NO. 1 ON FREE CARD

Portable SCSI Adapter

Belkin Components' Portable Parallel to SCSI Adapter connects up to seven SCSI devices to the parallel port of a laptop



or desktop computer. The device is compatible with both standard and enhanced parallel ports. $149. *Belkin Components, 1303 Walnut Park Way, Compton, CA 90220; tel.: 310-898-1100; fax: 310-898-1111.*

CIRCLE NO. 2 ON FREE CARD

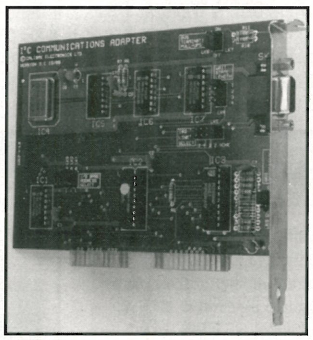
PCMCIA Diagnostic Card

Accurite Technologies' PC ReportCard is a PC Card size diagnostic card. Using the PC Report Card in conjunction with the company's PC ExtenderCard, all PC Card I/O and memory access cycles are displayed on a series of LEDs, allowing for quick diagnosis of a PC Card's hardware or software. $229. *Accurite Technologies, Inc., 231 Charcot Ave., San Jose, CA 95121; tel.: 408-433-1980; fax: 408-433-1716.*

CIRCLE NO. 3 ON FREE CARD

I2C Bus Card

Saelig Company's ICA-90B kit is designed to give you hands-on experience with the I²C bus. The kit includes an ICA-90 ISA half card and I²C



function library on disk with routines in C and TurboBASIC. The ICA-90B can demonstrate I²C master or slave mode in receiver and transmitter operations. $299. *The Saelig Company, 1193 Mosely Rd., Victor, NY 14564; tel.: 716-425-3753; fax: 716-425-3835.*

CIRCLE NO.4 ON FREE CARD

Windows 95 Keyboard

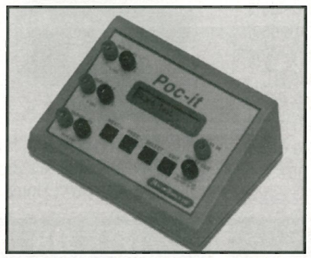
Mitsumi's ZW 104 Keyboard includes three new keys that make *Windows 95* computing easier. A Windows Key is used by the *Windows* operating system as a "hot key" to permit easy access to such functions as task switching and in-

stant availability of the Task Manager window. Two additional Application Keys are supported by applications designed for *Windows 95*. $34.95 *Mitsumi Electronics Corp., 6210 N. Beltine Rd., Ste. 170, Irving, TX 75063; tel.: 214-550-7300; fax: 214-550-7424.*

CIRCLE NO. 5 ON FREE CARD

Intermittent Detector

Version 1.1 of Poc-it from MicroTools is a diagnostic tool designed to troubleshoot and

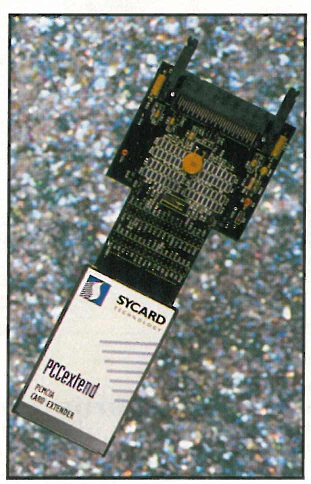


verify power on and intermittent failures. Poc-it can now be used with a logic analyzer to capture a failure when it occurs. $295. *MicroTools, Inc., PO Box 624, 714 Hopmeadow St., Ste. 14, Simsbury, CT 06070; tel.: 1-800-651-6170; fax: 203-6510019.*

CIRCLE NO. 6 ON FREE CARD

PC Card Development Tool

The PCCextend 100 PCMCIA Extender from Sycard Technology is a PCMCIA extender card that includes all of the standard extender card features, including test point ac-

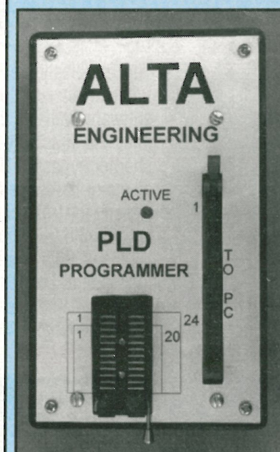


cess to all 68 pins and support for Type I, II and III cards. It also includes dual LEDs that inform you of card operating voltage and a current-protection device to guard the PC Card socket against damaged cards. $139.95. *Sycard Technology, 1180-F Miraloma Way, Sunnyvale, CA 9486; tel.: 408-749-0130; fax: 40-749-1323.*

CIRCLE NO. 8 ON FREE CARD

PLD Programmer

The Alta Engineering PLD Programmer is designed to program GAL16V8A/B, GAL20V8A/B and GAL22V10/B PLDs. The programmer consists of two parts: a multipurpose interface board installs in a PC and the PLD module that connects to the interface

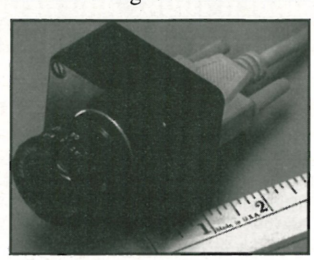


board via a 50-conductor ribbon cable. Included software accepts standard JEDEC files. $179. *Alta Engineering, 58 Cedar Lane, New Hartford, CT 06057; tel./fax: 203-489-8003.*

CIRCLE NO.7 ON FREE CARD

Digital Cameras

The EDC-1000M, L and D are three new digital cameras from

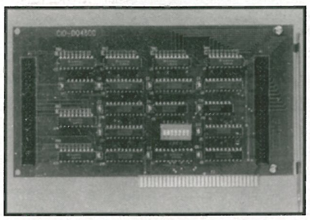


Electrim Corp. The cameras use low dark current, frame-transfer CCD detectors, and allow for software control of contrast, brightness, and color control (EC-1000D). ISA bus interface cards and software are included. $550/$800/$900, M/L/D. *Electrim Corp., 356 Wall St., Princeton, NJ 08540; tel.: 609-683-5546; fax: 609-683-5882.*

CIRCLE NO. 9 ON FREE CARD

Direct-Drive Boards

ComputerBoards' CIO-DO-24DD and CIO-DO4DD are direct-drive boards that are designed for switching circuits of



50 volts or 500 mA directly from a personal computer. For protection against transient voltages, the boards feature a clamping voltage input. $99/$139, 24/48. *ComputerBoards, 125 High St., Mansfield, MA 02048; tel.: 508-261-1123; fax: 508-261-1094.*

CIRCLE NO.10 ON FREE CARD

Memory Converter

SimmStack from Sermax Corp. adapts 30-pin SIMMs to 72-pin SIMMs. The converter accommodates four modules that range from 1M types to 8M. $39. *Sermax Corp., 207 E. 94th Street, Suite #301, New York, NY 10128; tel.: 212-410-1597.*

CIRCLE NO. 11 ON FREE CARD

Wave Daughterboard

Yamaha's WaveForce DB-50XG daughterboard is designed to take advantage of the Yamaha XG MIDI format. The board snaps onto any sound card that has a Wave-Blaster compatible connector and is fully General MIDI-compatible. It features 676 wavetable voices, 21 drum kits, 4M of ROM, extensive digital signal-processing effect functions and 32-note polyphony. $249. *Yamaha Corp. of America, PO Box 600, Buena Park, CA 90622; tel.: 714-522-9011.*

CIRCLE NO. 12 ON FREE CARD

1284 Port Card

The 1284Port from FarPoint Communications is a PC board that provides a high-speed, intelligent connection to the new generation of ECP-compatible printers. The board combines a fully compliant IEEE-1284 Level I parallel port with two 16550 serial ports. The parallel port supports a fast Centronics mode, as well as the EPP and ECP protocols. Data-transfer rate is up to 2M per second. $99. *FarPoint Communications, 104 E. Avenue K-4, Ste. F, Lancaster, CA 93535; tel.: 805-726-4420; fax: 805-726-4438.*

CIRCLE NO.13 ON FREE CARD

Portable Video Capture

VideoShot from VideoLabs is a palm-sized, stand-alone frame grabber for notebook and desktop PCs. The device plugs into a parallel port and

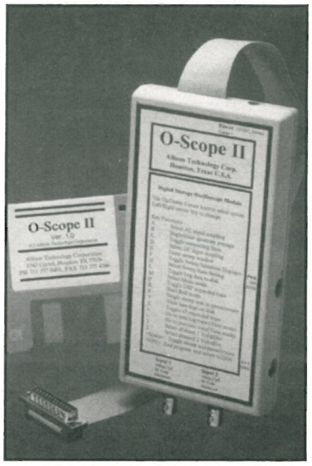
operates on three AAA cells. It can capture an image at 640 x 480 resolution in 16-million colors in 1/30 second.

Video Shot accepts both S-video and composite video, is TWAIN compatible, and works with all popular image-processing software. $229. *VideoLabs, Inc., 10925 Bren Rd. E., Minneapolis, MN 55343; tel.: 612-988-0055; fax: 612-988-0066.*

CIRCLE NO. 14 ON FREE CARD

PC Storage Scope

O-Scope II from Allison Technology transforms a PC into a

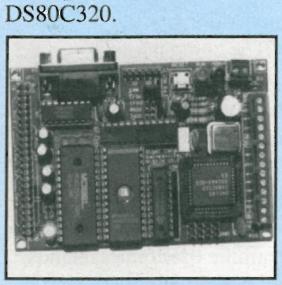


dual-trace digital storage oscilloscope. Operating parameters are displayed and adjusted through the PC's keyboard. The device features simultaneous two-channel data capture. Bandwidth is 250 kHz, with sampling rates up to 1 million per second. $349. *Allison Technology Co., 8343 Carvel, Houston, TX 77036; tel.: 713-777-0401; fax: 713-777-4746.*

CIRCLE NO. 16 ON FREE CARD

Embedded Controller

Rigel's R-51JX eight-bit embedded control board is designed for the Intel 80C251, Dallas Semiconductor 80C320 or Siemens 50x series of processors. The board is optimized to take advantage of the high-performance features found on these chips, including a can oscillator to allow for the various clock speeds, enhanced Vcc and GND shielding to lower noise interference, and two serial ports for use with the DS80C320.



The R-51JX has 12 I/O bits available on terminal blocks and 64K of on-board memory. Operating speed ranges from approximately 11 MHz to 40 MHz. The system bus is available on a header, where the address and data lines of the processor are de-multiplexed. $120. *Rigel Corp., PO Box 90040, Gainesville, FL 32607; tel.: 904-373-4629.*

CIRCLE NO. 15 ON FREE CARD

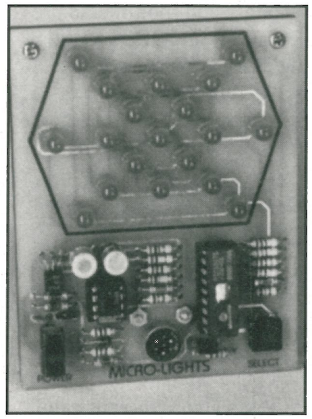
System Developers Kits

The SDK-LBC-104 and SDK-SAT-104 system developers kits from WinSystems facilitate software and hardware development. Each kit consists of MS-DOS 6.2, a 400M hard disk, 3½" floppy drive, triple-output power supply, keyboard and required cables to interface with WinSystems' LBC-486DX or SAT-SX/SLC embedded single-board computers. The kit permits the SBC and any PC/14 expansion boards to be mounted on top of the enclosure, with the peripherals packaged inside. The actual single-board computer is purchased separately. $895/ $895, LBC/SAT. *WinSystems, 715 Stadium Dr., Arlington, TX 76011; tel.: 817-274-7553; fax: 817-548-1358.*

CIRCLE NO. 17 ON FREE CARD

Light Show

Micro-Lights from Silicon Sound is a PIC16C71-controlled light show. The battery-

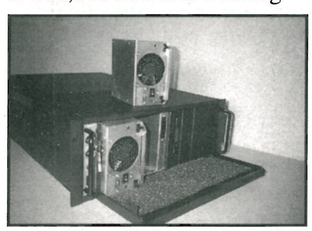


powered unit is available as a kit or pre-assembled and includes a microphone and eight pre-programmed "sound display" software routines. $59/ $69, Kit/Assembled. *Silicon Sound, PO Box 371694, Reseda, CA 91337; tel.: 818-996-5073.*

CIRCLE NO. 18 ON FREE CARD

High-Reliability PC

International Computers' Model 2714 rack-mount PC is a ruggedized system for mission-critical applications. Dual hot swap-able redundant power supplies bring the mean-time-between-failures (MTBF) to 100,000 hours. It's config-



ured with one or more Pentium or DX4/100 single-board computers on the backplane. International Computers, 12021 W. Bluemound Rd., Wauwatosa, WI 53226; tel.: 414-764-9000; sales: 800-992-9000; fax: 414-281-3522.

CIRCLE NO. 19 ON FREE CARD

Software

SCSI for *Windows* 95

Version 4.0 of Adaptec's *EZ-SCSI* software provides a suite of 32-bit applications and tools you can use with an ASPI-compliant host adapter to support virtually all major SCSI peripherals. These include SCSI Tape Backup, CD Writer and Copier, Photo CD Viewer and CD Player and SCSI Explorer, a collection of system-management tools. $99. *Adaptec, Inc., 691 Milpitas Blvd., Milpitas, CA 95035; tel.: 408-945-8600; fax: 408-262-2533.*

CIRCLE NO. 20 ON FREE CARD

QIC-80 Tape Backup

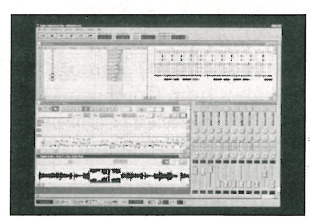
More Megs! from Gigatek Memory Systems combines the company's new higher-capacity QIC-80 mini-cartridges with NovaStor Corp.'s *NovaBack for Windows* soft-

ware. It permits you to increase your tape backup capacity to 350M without replacing their current 250M QIC-80 tape drive. $29.95. *Gigatek Memory Systems, 1989 Palomar Oaks Way, La Costa, CA 92009; tel.: 619-438-9010; fax: 619-438-9120.*

CIRCLE NO. 21 ON FREE CARD

Windows Sequencer

Voyetra's *Digital Orchestrator Plus* MIDI/digital audio sequencer for *Windows* lets you record or play independent digital audio tracks, which can be synchronized with MIDI tracks. Full drag-and-drop dig-



ital audio editing is provided, permitting layering of tracks to make space for additional recording. $159.95. *Voyetra Technologies, 5 Odell Plaza, Yonkers, NY 10701; tel.: 914-66-0600; fax: 914-966-1102.*

CIRCLE NO. 22 ON FREE CARD

Easy Software

T/Maker's *World's Easiest* software gives you the ability to design, create and professionally print letterhead, stationery, business cards, Post-it Brand Notes, rubber stamps, invitations and other items. You can print these from your own printer or send orders to Deluxe Corp., one of the nation's largest printing facilities. Modules include Certificates, Business/Personal Cards, Announcements, and Personal Image Bundle. $14.95 per module. *T/Maker Co., 1390 Villa St., Mountain View, CA 94041; tel.: 415-962-0195; fax: 415-962-0201.*

CIRCLE NO. 23 ON FREE CARD

RenderPrint for *Windows*

RenderPrint for Windows from Insight Development reads .BMP, .GIF, .JPEG, .PCX, .TIF and .TGA files of any size. Through its memory-saving Raster Image Compression Enhancement technology, the program lets you print images from raster image files as large as 100M, either through *Windows* or with included printer drivers, without adding printer memory. $249. *Insight Development Corp., 2420 Camino Ramon, Ste. 205, San Ramon, CA 94583; tel.: 510-244-2000; fax: 510-244-2020.*

CIRCLE NO. 24 ON FREE CARD

Upgrades

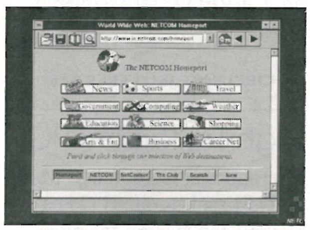
CorelDRAW! 6 Suite for Windows

The *CorelDRAW! 6 Suite for Windows* from Corel is a 32-bit graphics package that includes five full-featured applications for illustration, photo-editing and painting, business and multimedia presentations and 3D rendering and animation. Among the new features are accuracy to 0.1 micron, a new 3D logo-creation utility, an enhanced OCR/raster-to-vector conversion utility and extensive right mouse button support. $695. *Corel Corp., The Corel Bldg., 1600 Carling Ave., Ottawa, Ontario, Canada K1Z 8R7; tel.: 613-728-8200; fax: 613-761-9176.*

CIRCLE NO.25 ON FREE CARD

NetCruiser 2.0

NETCOM's *NetCruiser* 2.0 is a major upgrade to the company's integrated access services software. The program features an improved World Wide Web browser, in addition to a



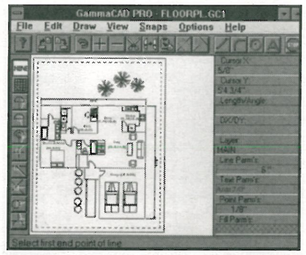
full battery of Internet-access tools. Additionally, this version provides one-touch access to The McKinley Internet Directory, AP and Reuters newswire stories, and the InfoSeek Net search tool. *NETCOM On-line Communications Services, Inc., 3031 Tisch Way, San Jose, CA 95128. tel.: 408-983-5950*

CIRCLE NO. 26 ON FREE CARD

QuickFlash 2.5

QuickFlash 2.5 from the ADM Group is a *Windows*-based, network messaging system that's geared to providing fast, effective communication for workgroups. The new version includes phone pad forms for telephone messages, paging pads, DDE capability and a power bar for easy access to all features. Version 2.5 accommodates up to 250 users and reads the network bindery, thus requiring little administration. 10-user pack, $299. *The ADM Group, 477 Madison Ave., New York, NY 10022; tel.: 212-750-7400; fax: 212-750-7419.*

CIRCLE NO.27 ON FREE CARD



GammaCAD Pro 2.0

GammaCAD Pro 2.0 from Gamma Software adds many new features, including lossless .DXF transfer and the ability to set up a printer/plotter page automatically. The program runs under *Windows* 3.1 or later. $25. *Gamma Software, PO Box 8191, Fort Collins, CO 80526; tel.: 303-490-2928.*

CIRCLE NO. 28 ON FREE CARD

Smacker 2.0

RAD Software's *Smacker* 2.0 video compressor specifically is designed for eight-bit video and animation data. The new version incorporates more than 100 new features including *Windows 95* support, sound support on all platforms, sound compression and others. $195. *RAD Software, 307 W. 200 S., Ste. 1003, Salt Lake City, UT 84101; tel.: 801-322-4300; fax: 801-359-6169.*

CIRCLE NO. 29 ON FREE CARD

Books

Visual BASIC Controls Desktop Reference CD

By Mark Pruett, Greg Irwin & C. Woody Butler

(*Waite Group Press. Soft cover. 856 pages. $44.95 With CD-ROM.*)

Where do you look for the *Visual Basic* controls you need from among the literally hundreds of third-party ones on the market. The answer is *Visual Basic Controls Desktop Reference*. This Book/CD-ROM package focuses on extensions that enhance *Windows* applications. It describes and reviews more than 100 of the most-popular and powerful controls in the after-market arena. With the included CD-ROM, it gives you the opportunity to view each control in action to check out if it's what you need.

Visual Basic Controls Desk Reference can save you hundreds of programming hours by zeroing in on the controls that solve specific development problems. It shows you how to augment your *VB* applications with everything from meters and gauges to full-blown word processing, data compression and telecommunications. Sections arranged by control functions make comparing and evaluating similar controls a snap. Twelve chapters demonstrate the use of third-party controls to optimize a full range of applications, from image processors, text editors, databases and report writers to graphics, grids, spreadsheets and multimedia applications.

The companion CD-ROM contains a sample program that features practical examples of each control so that you can see and evaluate it. Tutorials, examples, resources and demos let you examine the controls hands-on. Additionally, expert *Visual Basic* programmers provide professional evaluations of each control and its particular features and customized functions.

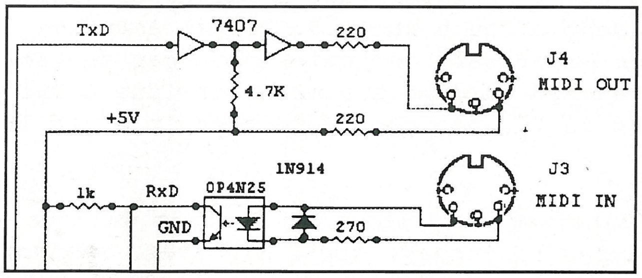
This reference guide covers all the major custom controls and control libraries. Sources include Crescent, Desaware, MicroHelp, FarPoint, Microsoft and VideoSoft. There's also a wide range of innovative shareware controls.

Letters

MIDI Connector Correction

In *MicroComputer Journal* for September/October 1995 on page 97 is a wiring diagram showing some MIDI connections. While the proper pin numbers are given (4 and 5), the diagram shows them in the wrong place. Luckily, some five-pin DIN connectors have pin numbers molded into the insulating plastic that surrounds each pin. But someone who is attempting to wire the Q&A schematic might just look at the drawing and wire to the last two pins.

As I recall, MIDI output connectors are also supposed to have a GND connection on pin 3, which should also connect to the cable's shield (although *why* the MIDI folks decided to do this has never been clear to me—it would take a hefty external interference to induce a 5-mA current flow in the MIDI cable!). Here's how it should look, physically.—Larry Chace, via Internet



You're quite correct about the physical appearance. The reason for the odd numbering arrangement of the five-pin DIN connector is because it's a three-pin DIN upgrade. Imagine pins 4 and 5 (the two connected in the diagram above) missing, and the numbering makes sense. The original three-pin DIN connector is still very much in use as an audio cable for stage and screen.

Originally, pins 1 and 2 were a twisted pair, and pin 3 was the shield. Without going into a lot of detail, this is the best way to prevent hum from the heavy ac currents spewed out by the stage lights. The first time I saw a five-pin DIN connector, it was on the back of a 15" open-reel tape deck of German origin. I also remember using a three-pin adapter to interface our microphones to the tape deck's five-pin socket—which is why, I assume, the numbering is as it is. I also have to assume that MIDI avoided using pins 1 and 2 to prevent conflicts with existing audio wiring convention. Finally, there's pin 3, which now serves as both signal and shield ground. The correct way to connect to pin 3 is through a separate ground wire (usually white) plus the shield.

Speaking of odd conventions, I've often wondered why the neutral cable in house wiring is white and black is hot, when in electronics equipment black is ground and red is hot; or why US wall switches are "on" in the up position and in the UK they're "off" in this position.—TJ Byers

File Delete & DOS

In the September/October "Microcomputer Q&A" column there was a batch file for wiping clean a file. As written, the batch file will work only if there are no other file deletions in the directory before the file to be purged. When DOS creates a file, it uses the first available entry in the directory. If the file you wish to obliterate isn't the first empty entry, the file isn't overwritten, leaving it vulnerable to Undelete. For example, let's say you have two files, FILEA.BAK and FILEB.TXT. Now let's say you erase FILEA.BAK on Monday as a way to free up disk space and decide to wipe FILEB.TXT clean on Tuesday. Using the batch file suggested, the seed file will be written to the space previously occupied by FILEA.BAK, not FILEB.TXT.

The process works much better if you *don't* erase the file at the start of the batch process and overwrite the target file instead, like this:

```
COPY C:\COMMAND.COM %1 /Y
ERASE %1
```

When dealing with really sensitive files, I do a Defrag before leaving my desk. It thoroughly scrambles the contents of the disk and rewrites the directories, omitting deleted file names.—Jim DeVries, via Internet

INTERNET HAPPENINGS. Bell Atlantic donated $1.5-million for the Library of Congress National Digital Library Program. The Program aims to digitize 5-million items by the year 2000 and make them available over the Internet. Nearly $18-million has been raised for the project, bringing it closer to a $45-million private funding goal ....The Web BBS from Software Creations (tel.: 508-368-7036) allows anyone to operate a BBS on the World Wide Web. It features full file descriptions, file-search engine and quick download via HTTP protocol. Subscribers need only a web browser to access and use it. You can check out the prototype at http://www.swcbbs.com....Internet retailer offers more than 1-million book titles. If printed as a catalog, it would be the size of seven New York City telephone books. Reach it at http//www.amazon.com ....A new Internet-based mailing service, called the OutPost Network (http://www.outpost.net), allows users to write messages on their computers for printing on greeting cards, postcards or stationery, stamped and sent through the U.S. Postal Service. Outpost offers a wide selection of cards from major card companies that can be viewed on one's video monitor. The service can be reached through any major on-line service. Cost for the whole thing ranges from $2.95 to $3.75, not much more than it would if you bought it at a store.

COMPUTER ROBOT CONTEST. The third annual International Robotics Contest will be held on the Trinity College, Hartford, CT campus on Sunday, April 21, 1996. Sponsored by the college and the Connecticut Robotics Society, the day-long event offers prizes of $1,000 each to winners in a junior division and an anyone-older division. The computerized robotic device, which can't be radio-controlled, must move through a model of a house's single-floor, detect fire (a lit candle) and then extinguish it. Robots that do this in the shortest time are the winners. Contest entry costs $20 per robot; deadline is March 15, 1996. For a copy of contest rules, send $3 payable to Trinity College, Jake Mendelssohn, 190 Mohegan Drive, West Hartford, CT 06117. For more information, call 860-297-2588.

TRAVELING MESSAGES. ZAP-it is among the growing wireless computer-message systems available. Using a wireless modem, ZAP-it software and a 386 or later computer or HP-95/100/200 LX palmtop computer, one can send faxes and e-Mail from a laptop or notebook PC to achieve mobile messaging without telephone lines. The service costs $9.95 per month plus low per-message usage charges and a one-time $34.95 activation fee. For more information call 1-800-967-0943.

CENTRAL INSTRUCTOR CONTROL STATION. Minicom Advanced Systems of Holland, MI announced Version 3 of its CLASSNET all-hardware system for training environments. The system allows an instructor to control the keyboard, mouse and video monitor for up to 64 computers, working with one, some or all students without leaving the control unit. At the station, the instructor can broadcast individual screens, override any student's keyboard or mouse to provide on-line assistance, darken screens to command attention and, with an intercom option, communicate privately. CLASSNET operates regardless of hardware or operating system, it's claimed. For a demo disk and more information, call 800-922-8020.

TESTING. A new diagnostic product for servicing laser printers, LaserTest SX30, tests any laser printer that has a Canon SX engine. This amounts to about 246 models. With the instrument, a technician can identify the cause of noise, false error messages and other symptoms. It checks all high-voltage functions, troubleshoots for broken gears, bad toner cartridges, bad system and controller boards and bad erase lamp assembly, among others. A key to Hewlett Packard's "Non-Descript Error Codes" is also printed on the unit's rear panel. Made by Laser Wizard. Check out the $295 product in Jensen Tools' catalog (tel.: 800-366-9662).

By Jan Axelson

Computer-Controlled Power Switching

Solid-state and electromechanical devices you can use to switch power to controllable loads

Computers are great for storing and processing text, numbers and anything that can be expressed in binary form. But they can do more than devote themselves to data processing and storage. For example, you can also use a computer as a smart controller for just about anything that's powered by electricity.

A simple example is when you want to be able to switch a circuit on and off under computer control. The circuit may be powered by 5 volts dc or another dc voltage, or by line voltage (117 volts ac). The controlling device may be a personal computer or a microcontroller. The program that controls the switches might use sensor readings, time/day/date information, user input or other criteria to decide when to switch the circuit on or off.

To switch power to a circuit, you need an interface between the computer's logic output and the power connection to the circuit, or load, you want to power. In an electromechanical relay, applying a voltage to its coil causes a pair of contacts to physically separate or close together. Other switches are entirely electronic, with no moving parts, and operate by opening and closing a current path in a semiconductor.

In this article, I explore the options for computer-controlled switches that control power to an external circuit. The components in my example circuits are available from Digi-Key (tel.: 1-800-344-4539), though other suppliers carry them as well.

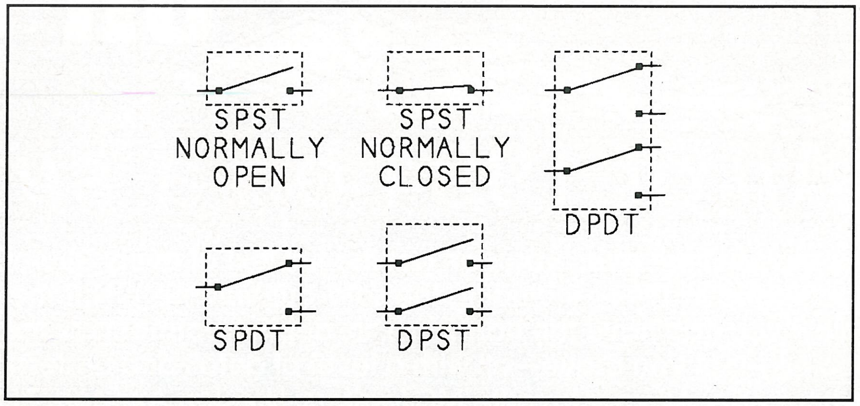


Fig. 1. Five types of mechanical switches. You can emulate any of these with an electronically controlled switch.

Choosing a Switch

All switches contain one or more pairs of switch terminals, which may be mechanical contacts or leads on a semiconductor or integrated circuit. In addition, electronically controlled switches have control terminals that enable you to open and close the switch, usually by applying and removing a voltage across the terminals.

An ideal switch has three characteristics. When the switch is open, the switch terminals are completely disconnected from each other, with infinite impedance between them. When the switch is closed, the terminals connect perfectly, with zero impedance between them. Finally, in response to a control signal, the switch opens or closes instantly and perfectly, with no delay or bounce.

As you might suspect, although there are many types of switches, not one meets the ideal. You need to find a match between the requirements of your circuit and what's available. Switch specifications include the following:

- **Control Voltage and Current.** The control terminals have defined voltage and current levels at which the switch opens and closes, and your circuit's control signal must meet these requirements.
- **Load Current.** The switch must be able to safely pass currents that are greater than the maximum current your load will require.
- **Switching Voltage.** This is the maximum safe voltage across the switch terminals, and it must be greater than the voltage to be switched.
- **Switching Speed.** For simple power switches, speed is rarely a critical consideration, but there are applications in which speed does matter. For example, a switching power supply may switch current to an inductor at rates of 20 kHz or greater frequency. You can calculate maximum switching speed from switch turn-on and turn-off times, using the formula Maximum Switching Speed = 1/(Maximum Turn-On Time + Maximum Turn-Off Time).

Other factors to consider are cost,

Table 1. Output Currents & Voltages of Popular Logic Gates, Buffers and Microcontrollers.

Integrated Circuit Chip	Output High Voltage (VOH Minion)	Output Low Voltage (VOL Maximum)	Supply Voltage	Absolute Maximums
74LS374 Flip-Flop, 74LS244 Buffer	2.4 Volt @ –2.6 mA	0.5 Volt @ 24 mA	4.5 to 5.5	
74HC(T)374 Flip-Flop, 74HC(T)244 Buffer	Vcc to 0.1 Volt @ 20 mA 3.84 Volt @ 6 mA	0.1 Volt @ 20 mA 0.33 Volt @ 6 mA	4.5	35 mA/Pin, 500 mW/Package
74LS14 Inverter	2.7 Volt @ –0.4 mA	0.5 Volt @ 8 mA	4.5 to 5.5	
74HC(T)14 Inverter	4.4 Volt @ 20 MA 4.2 Volt @ 4 mA	0.1 Volt @ 20 mA 0.33 Volt @ 4 mA	4.5	25 mA/Pin, 500 mW/Package
8051	2.4 Volt @ –80 mA	0.45 Volt @ 1.6 mA	4.5 to 5.5	
80C51	Vcc to 0.3 Volt @ –10 mA Vcc to 0.7 Volt @ –30 mA Vcc-1.5 Volts @ –60 mA	0.3 @ 100 mA 0.45 Volt @ 1.5 mA 1.0 Volt @ 3.5 mA	4 to 5	10 mA/Pin; 15 mA/Port, 71 mA/All ports
68HC11	V_{DD} to 0.8 Volt @ 0.8 mA	0.4 Volt @ 1.6 mA	4.5 to 5.5	25 mA/Pin; Observe Power Dissipation Limit For Chip
PIC16C5x	V_{DD} to 0.7 Volt @ 5.4 mA	0.6 Volt @ 8.7 mA	4.5	+25/-20 mA/Pin, +50/-40 mA/Port, 800 mW/Package

physical size of the switch and, of course, availability.

Shown in Fig. 1 are some common configurations available in mechanical switches. You can find electronic switches in the same configurations, or you can build the more complex ones from simpler switches.

As the name suggests, a normally-open switch is open when no control voltage is applied to it, and closes on applying a control voltage. A normally-closed switch is the reverse—it's closed with no control voltage and opens on applying a voltage.

A double-throw (dt) switch connects a switch terminal to either of two contacts, depending on the control voltage. A double-pole (dp) switch controls two sets of terminals with one control signal. And a double-pole, double-throw (dpdt) switch has two sets of terminals, each with two contacts.

Logic Outputs as Switches

For a low-current, low-voltage load, you may be able to use a logic gate or output port bit as a switch. At greater currents or voltages, you might use a logic output to drive a transistor that, in turn, controls current to the load. In either case, knowing the characteristics of the logic output is important.

Table 1 lists output voltages and currents for some popular microcontrollers, logic gates and buffer/driver chips. The abilities of the outputs are greater than you might think by looking at the specifications. The figures show minimum output currents at specific voltages. These are usually the minimum logic-high and the maximum logic-low outputs for the logic family.

Many logic outputs can drive low-voltage loads of 10 to 20 mA. For example, you need just 1.4 volts to turn on a LED. Because you're not driving a logic input, you don't have to worry about valid logic levels. All that matters is being able to provide the voltage and current the LED requires.

In general, to use a logic output to drive a load other than a logic input, you need to know the output's current sourcing and sinking ability and the power-dissipation limits of the chip.

Illustrated in Fig. 2 are source and sink currents. You might think of a logic output as something that "out-

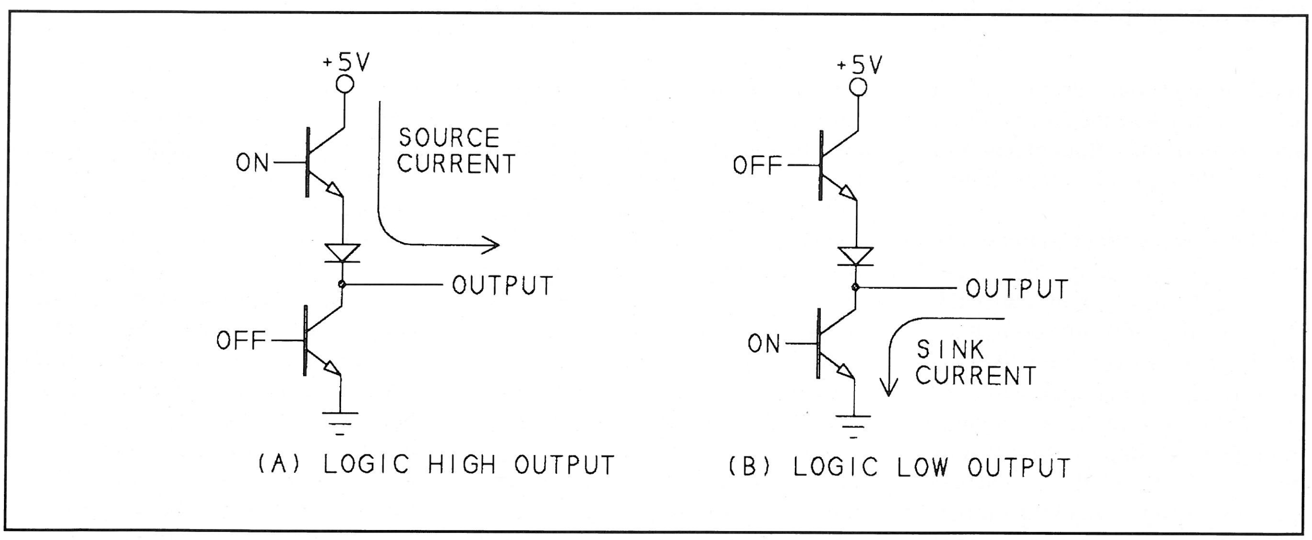


Fig. 2. A logic-high output sources current from the power supply, and a logic-low output sinks current to ground.

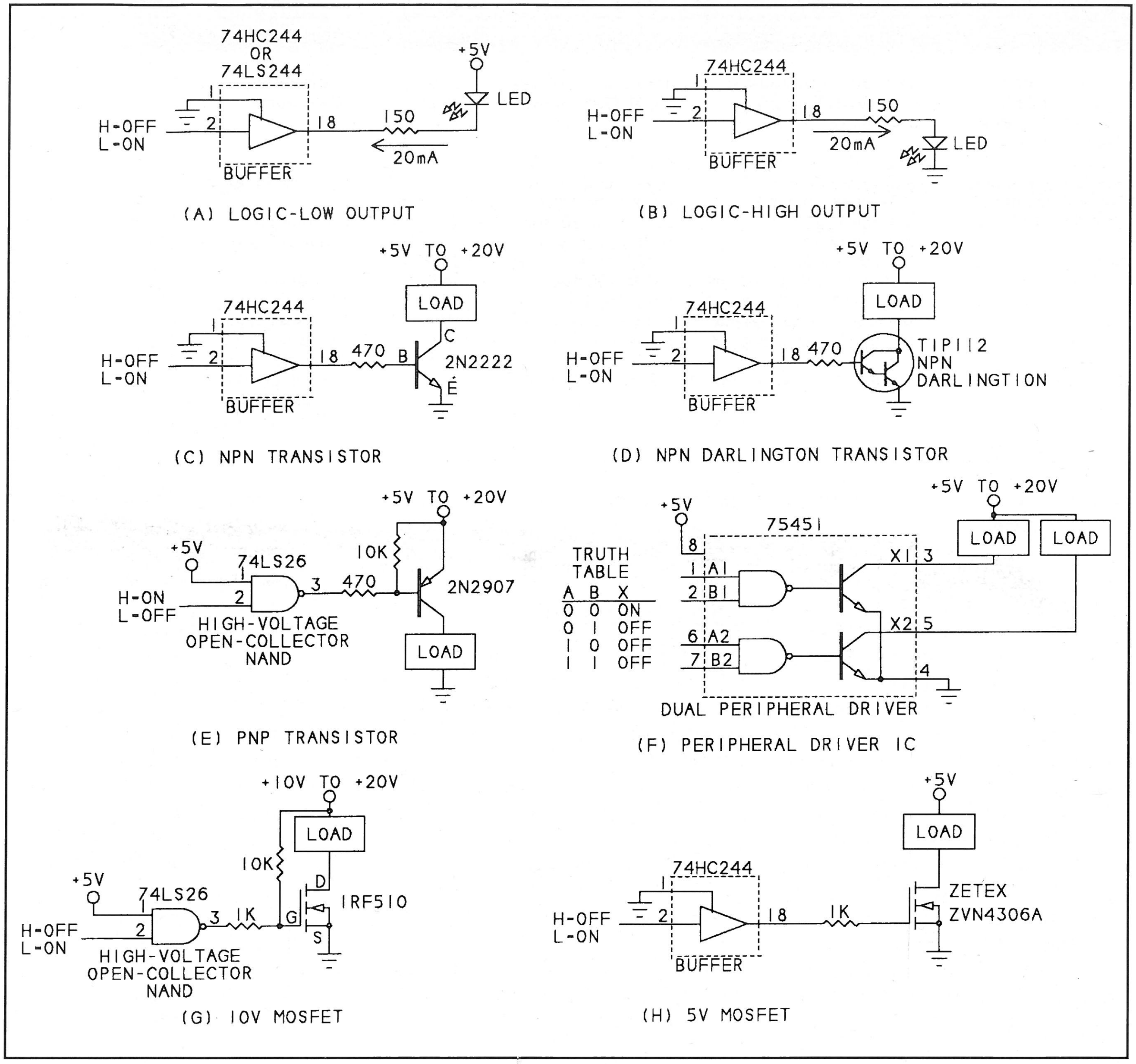


Fig. 3. Eight simple circuits for using a logic output to switch power to a load.

puts," or sends out, current. In fact, however, whether the current flows into or out of the output depends on whether the output is a logic high or logic low.

A logic-high output sources current from the power supply, and a logic-low output sinks current to ground. You can think of source current as flowing from a logic-high output through a load to ground, while sink current flows from the power supply through a load into a logic-low output. Usually, the load is a logic input, but it can be any circuit the output drives. Data sheets often use negative numbers to indicate source current.

CMOS logic outputs are symmetrical, with equal current-sourcing and current-sinking capabilities. In contrast, TTL and NMOS outputs can sink much greater current than they can source. If you want to use a TTL or NMOS output to drive a load, design your circuit so that a logic-low output turns on the load.

All circuits should be sure to stay well below the chip's absolute maximum ratings. For example, because an ordinary 74HC gate has an absolute maximum output of 25 mA per pin, you could use an output to drive a LED at 15 mA. (Use a current-limiting resistor that has a value of 220 ohms.) If you want 20 mA, a better choice would be a buffer like the 74-HC244 that has an absolute maximum output of 35 mA per pin. Illustrations (A) and (B) in Fig. 3 show examples.

For microcontrollers, specifications can be more complicated. In addition to considering the maximum output per port bit, you sometimes have to consider the total current per port and even the total for all of the ports combined. For example, a port output of the PIC16C5x series can sink up to 25 mA and source up to 20 mA, but the total at any port must be no greater than 50 mA sink and 40 mA source current. Again, since these are abso-

lute maximum ratings, your designs should stay well below them.

Overall, if you have one or two outputs that must provide several milliamperes of current, chances are good that you can use a microcontroller's port pins to provide the current.

If you need more than a few high-current outputs, you can use the port outputs to drive a buffer like the 74-HCT244. Because a buffer also helps to isolate the computer from the load-control circuits, if something goes wrong, you'll destroy a low-cost buffer rather than an expensive computer chip.

You can use outputs like those of the 74HC24x series or a 74HC(T)374 octal flip-flop, or the equivalent in LSTTL logic, to drive a cable of 10 feet or so length. In fact, the original PC's parallel port used a 74LS374 to drive the data lines from the PC to the printer.

If you're using parallel-port outputs of a PC as control signals, use an LSTTL or 74HCT buffer at the far end of the cable. This ensures a clean control signal at the switch. Also, because the specific components that drive parallel-port outputs can vary, using a buffer (which any parallel-port output should be able to drive) eliminates having to concern yourself with the limits of your port.

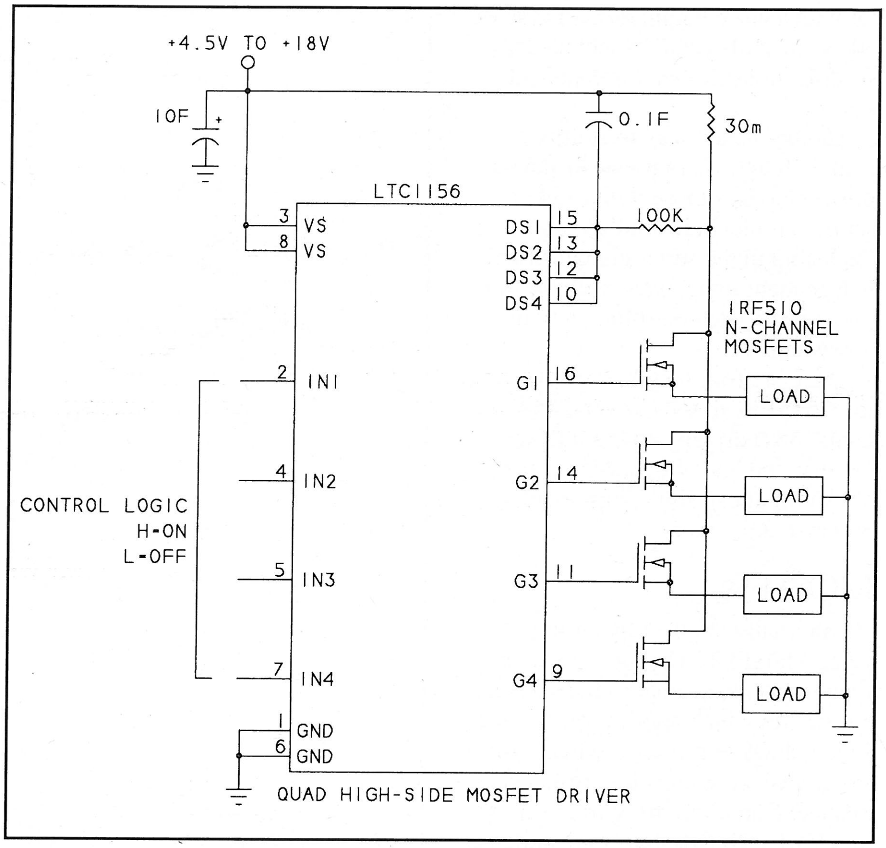


Fig. 4. With Linear Technology's LTC1156, you can control four n-channel MOSFETs used as high-side switches.

Bipolar Transistors

If your load needs greater current or voltage than a logic output can provide, you can use an output to drive a simple transistor switch. A bipolar transistor is an inexpensive, easy-to-use current amplifier. Although the variety of transistors available can be bewildering, for many applications you can use any general-purpose or saturated-switch transistor that meets your voltage and current requirements.

Shown in Fig. 3(C) is a circuit that uses a commonly available 2N2222 general-purpose npn transistor. A logic high at the control output biases the transistor into its on condition. A small current flows from base to emitter, and the resulting low collector-to-emitter resistance permits current to flow from the power supply through the load and switch to ground.

When the transistor is switched on, there's a small drop of about 0.3 volt from collector to emitter. Hence, the entire power-supply voltage isn't applied across the load.

The exact value of the transistor's base resistor isn't critical. Values from a few hundred to 1,000 ohms are typical. The resistance just needs to be small enough so that the transistor can provide the current to power the load, yet is great enough to protect the logic output and transistor from high currents.

The load's power supply can range from 5 volts dc on up. If it's greater than 12 volts dc, check your transistor's collector-emitter breakdown voltage (V_{CEO}), to be sure it's greater than the supply voltage that will be across the terminals when the switch is off.

For large load currents, you can use a Darlington pair, as illustrated in Fig. 3(D). One transistor in the pair provides the base current to drive a second transistor. Because total current gain equals the gain of the first times the gain of the second, gains of 1,000 are typical for Darlington pairs.

The TIP112 is an example of a Darlington pair that's packaged in a single TO-220 case. It's rated for a collector current of 2 amperes and collector-to-emitter potential of 100 volts. A drawback is that the collector-to-emitter voltage of a Darlington pair is about a volt, which is much greater than that for a single transistor.

All the above circuits use npn transistors and require source current from a logic-high output to switch on. If you want to turn on a load with a logic-low output, you can use a pnp transistor, as illustrated in Fig. 3(E). In this circuit, a logic-low output biases the transistor on, and a voltage equal to the power supply potential switches it off.

If the load's power supply outputs greater than 5 volts dc, you must use a high-voltage, open-collector or open-drain output for the control signal so that the pull-up resistor can safely pull logic-high outputs to the supply voltage.

Be sure your transistor's maximum collector current (I_C) is greater than your load requires. Look for a transis-

tor with a current gain (h_{FE}) of at least 50. Some parts catalogs include these specifications, for easy component selection.

Another handy way to control a load with logic is to use a peripheral-driver chip like those in the 7545X series and illustrated in Fig. 3(F). Each chip in the series contains two independent logic gates, with the output of each gate controlling a transistor switch.

There are four members of the series: 75451 dual AND drivers; 75452 dual NAND drivers; 75453 dual OR drivers; and 75454 dual NOR drivers. Each output can sink a minimum of 300 mA at 0.7 volt.

MOSFETs

An alternative to the bipolar transistor is the MOSFET. The most popular type is an enhancement-mode n-channel type in which application of a positive voltage to the gate switches on the device, creating a low-resistance channel from drain to source. An example of such a design is illustrated in Fig. 3(G).

P-channel MOSFETs are the complement of n-channel MOSFETs, much as pnp transistors complement npn transistors. A p-channel MOSFET switches on when the gate is more-negative than the source. In depletion-mode MOSFETs (which may be n- or p-channel), applying a gate voltage opens the switch, rather than closing it.

Unlike a bipolar-transistor switch, which can draw several milliamperes of base current, a MOSFET gate has very high input resistance and draws virtually no current. But unlike a bipolar transistor, which needs just 0.7 volt from base to emitter, a MOSFET may require 5 or even 10 volts from gate to source to switch fully on.

One way to provide the gate voltage from 5-volt logic is to use a device with an open-collector or open-drain output with a pull-up resistor to at least 10 volts, as illustrated in Fig. 3(G). Alternatively, you can look for a device with a low minimum on voltage. Zetex's ZVN4603A can switch 1.5 amperes with just +5 volts applied to the gate, as illustrated in Fig. 3(H).

Since MOSFETs do have a small on resistance, there's a voltage drop

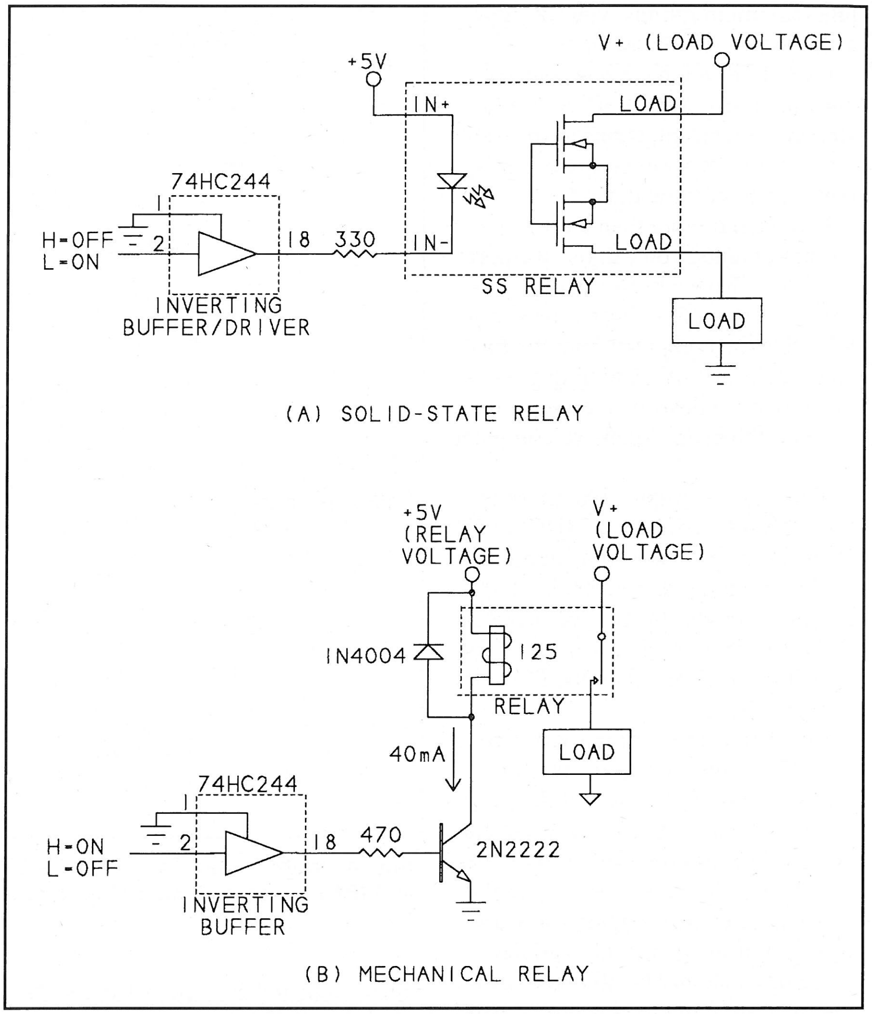


Fig. 5. Solid-state and electromechanical relays are two more options for power switching.

from drain to source when the device is switched on. The on resistance of the ZVN4603A is 0.45 ohm at 1.5 amperes, which results in a drop of about 0.7 volt. At lesser currents, resistance and voltage drop are less.

Include the gate resistor if you're switching a relay, motor or other inductive load. Its exact value isn't critical.

High-Side Switch

Another way of controlling a load with a logic voltage is to use a high-side switch like the LTC1156, a quad high-side MOSFET driver chip from Linear Technology (Fig. 4). This chip costs a little more ($8.75 in single quantity from Digi-Key), but it adds some useful features and also allows you to use the less-expensive, more widely available n-channel MOSFETs in your designs. Single and dual versions are available at lower cost, and other manufacturers have similar chips.

Most of the previous circuits use a low-side switch, where the switch connects to ground and the load's ground terminal. In a high-side switch, the load's ground terminal connects directly to ground and the switch is between the power supply and load's power-supply terminal.

A high-side switch offers a couple of advantages. For safety reasons, some circuits are designed to be off if the switch terminals should short to ground. With a low-side switch, shorting the switch to ground would apply power to the load. With a high-side switch, although shorting the switch to ground may destroy the switch itself, it removes power from the load.

Connecting the load directly to ground can also help to reduce electri-

cal noise in a circuit. With a low-side switch, the load always floats a few tenths of a volt above ground potential.

The LTC1156 can control up to four MOSFETs. You can use any 5-volt TTL or CMOS outputs as control signals because the switches turn on at just 2 volts.

Providing a sufficient gate voltage can be a problem when using an n-channel MOSFET in a high-side switch. When the MOSFET switches on, its low drain-to-source resistance causes the drain to rise nearly to the supply voltage level. But for the MOSFET to remain on, the gate must be more positive than the source. The LTC1156 takes care of this with charge-pump circuits that bring the gate potential to as much as 20 volts greater than the supply voltage.

By adding a small-value current-sensing resistor, you can cause the outputs to switch off if the MOSFETs' drain current rises above a selected value (3.3 amperes with 30 milliohms in the circuit shown). The outputs switch off when the drop across the current-sensing resistor is 100 mV.

Solid-State Relays

Another way to switch power to a load is via a solid-state relay, which offers an easy-to-use optically-isolated switch in a single package. Shown in Fig. 5(A) is an example.

In a typical solid-state dc relay, applying a voltage across the control inputs causes current to flow in a LED. (Because the LED is enclosed in the relay package, you don't see its output.) The energy from the LED switches on a photodiode, and the voltage across the photodiode causes a control voltage to be applied to a MOSFET's gate, switching on the MOSFET. The result is a low resistance across the switch terminals, which, in effect, closes the switch and permits current to flow. Removing the control voltage turns off the LED and opens the switch.

You can buy solid-state relays for a variety of load voltages and currents. Because the switch is optically isolated, there need be no electrical connection between the control signal and the circuits being switched.

Solid-state relays have an on resistance of anywhere from a few ohms to several hundred ohms, with the higher-voltage relays tending to have greater on resistances. Solid-state relays also have small leakage currents of typically a microampere or so that flow through the switch, even when they're off.

There are solid-state relays for switching ac loads as well. These provide a very simple and safe way to use a logic signal to switch line voltage to a load. The switch itself is normally an SCR or a TRIAC. Zero-voltage-switches minimize noise by switching only when the ac voltage is near zero.

Electromechanical Relays

Mechanical, or electromagnetic, re-

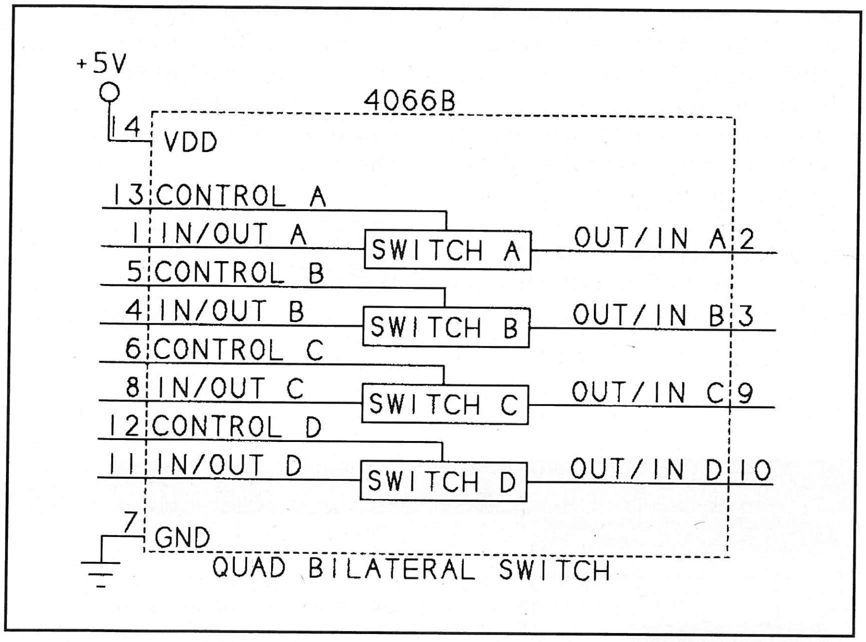


Fig. 6. The 4066B quad switch is an inexpensive way to switch low-frequency analog or digital signals.

lays have been around longer than transistors and still have their uses. An electromechanical relay contains a coil and one or more sets of contacts attached to an armature, as shown in Fig. 5(B). Applying a voltage to the coil causes current to flow through it. The current generates magnetic fields that move the armature to open or close the relay contacts. Removing the coil voltage collapses the magnetic fields and returns the armature and contacts to their original positions.

A diode across the relay coil protects the components from voltage spikes that would otherwise occur when the contacts open, cutting off the current path through the coil. In fact, you should place a diode in this way across any switched inductive dc load, including motor windings. For ac loads, use a varistor in place of the diode.

Two attractions of electromechanical relays are very low on resistance and complete isolation from the control signal. Because the contacts physically connect to each other, the on resistance is typically just a few tenths of an ohm. And because the contacts open or close in response to magnetic fields, there need be no electrical connection between the coil and the contacts.

Drawbacks include large size, hefty current requirements (50 to 200 mA is typical for coil current), slow switching speed and the need for maintenance or replacement as the contacts wear.

Analog Switches

A different type of switch worth mentioning is the CMOS analog switch. Instead of applying and removing power to and from a load, an analog switch passes or cuts off an analog signal, such as an audio or video waveform.

The 4066B is useful for switching low-frequency signals. As shown in Fig. 6, the chip has four control inputs, each of which controls two I/O pins. A logic-high at a control input causes its I/O pins to connect, and a logic-low opens the switch. With a 5-volt power supply, the on resistance of each switch is about 270 ohms, dropping at higher voltages. The 74-HC4066 version also has a lower on resistance of about 100 ohms.

A more-elaborate version of this type of switch is the 8 X 8 crosspoint switch, which permits you complete control over the routing of two sets of eight lines. Examples are Maxim's MAX455 and Harris' 74HCT22106.

X10 Switching

Finally, a brief note on one more way to control power to devices driven by the 117-volt ac line is in order. The X10 protocol lets you send on, off and dim commands to a device using a low-voltage signal carried on 117-volt, 60-Hz power lines. It's a simple way to control lights and plug-in appliances using only the existing wiring in the building.

Manually-programmed X10 controllers and appliance modules are available at Radio Shack and elsewhere. You can also buy software that enables you to program an X10 controller from a PC, usually using a serial link to communicate with the controller.

Moving On

That's all for now. Your comments, questions, etc. are invited. You can reach me at this e-mail address: jaxelson@mailbag.com. ■

Jan Axelson

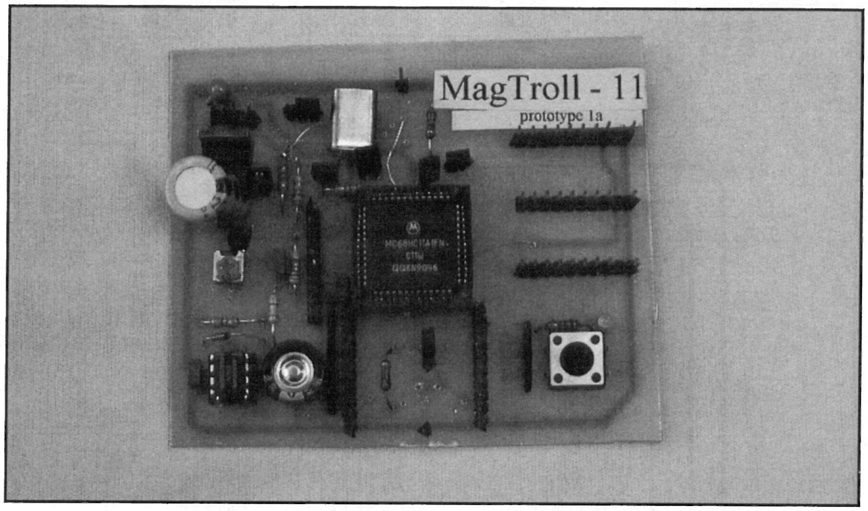
By Tom Fox

A 68HCx11 EEPROM Programmer/ Mini-Development System

Part 2

A simple low-cost, minimum-chip controller board

In Part 1 of this series, I introduced you to a few features of Motorola's 68HCx11 family of microcontrollers. The feature I emphasized was its internal EEPROM, which consists of 512 bytes for the MC68HC11A1FN and 2K bytes for the MC68HC811E2FN. I also covered construction and use of MAGPRO-11, the primary purpose of which is to serve as an EEPROM programmer, although it also can be used as a mini-development system. This time, I'll show you how to make use of an HCx11's programmed EEPROM to create a simple and inexpensive minimum chip, multi-purpose Magtroll-11 controller board. Magtroll-11 instructions will be contained in the HCx11's EEPROM.



About the Circuit

Magtroll-11 is basically a single-chip computer board, even though it contains three other ICs. It was designed with simplicity and economy in mind.

Referring to Fig. 1, LM7805CTB +5-volt voltage regulator *U4* is optional if power for the board is to be a regulated 5 volts dc. If optional *U3* isn't used, a jumper must be placed on pins 2 and 3 of *JP4*. Leaving out these options leaves you with a two-chip board.

The purpose of *U2* is three-fold. It provides the protective supervisory function of keeping low the HCx11's RESET input whenever the Vcc pin of *U1* is at less than 4.65 volts (this protects the CONFIG register). Next, *U2* provides automatic RAM back-up control when power fails. Finally, *U2* provides an interrupt signal whenever it detects power is in the process of failing. This interrupt signal is applied to the XIRQ input of *U1*, which can force the program to instruct the HCx11 to enter its ultra-low-power STOP state. This is another way of saving the contents of the HCx11's internal RAM.

Jumper blocks *JP3* and *JP5* permit you to select the chip's mode, while jumper *JP2* provides the means for you to select a direct jump to EEPROM for MC68HC11A1FN chips when Special Bootstrap mode is selected (Table 1). Low-power *LED1*, connected to Bit 4 of Port A in *U1*, functions primarily as an MCU-check indicator. It turns on when Bit 4 of Port A is cleared. Otherwise, it's off.

Male headers J-PORTA through J-PORTE and J-MISCL connect to external circuits. Notice that while Magtroll-11 was designed to be used primarily in single-chip mode (either Normal or Special Bootstrap), it can be used in expanded mode (either Normal or Special Test). However, to be used in expanded mode, Port C must be de-multiplexed to extract the low-order address bus from the data bus. This can be accomplished with an 74HC373 or 74HC573 octal transparent latch located on an external board, as shown in Fig. 2. Note that while the 74HC373 and 74HC573 are logically equivalent, they differ in pinout arrangements.

Construction

Despite the relative simplicity of Magtroll-11, use of a printed-circuit board on which to wire its components is highly recommended. If you wish to fabricate the required double-sided pc board yourself, you can do so

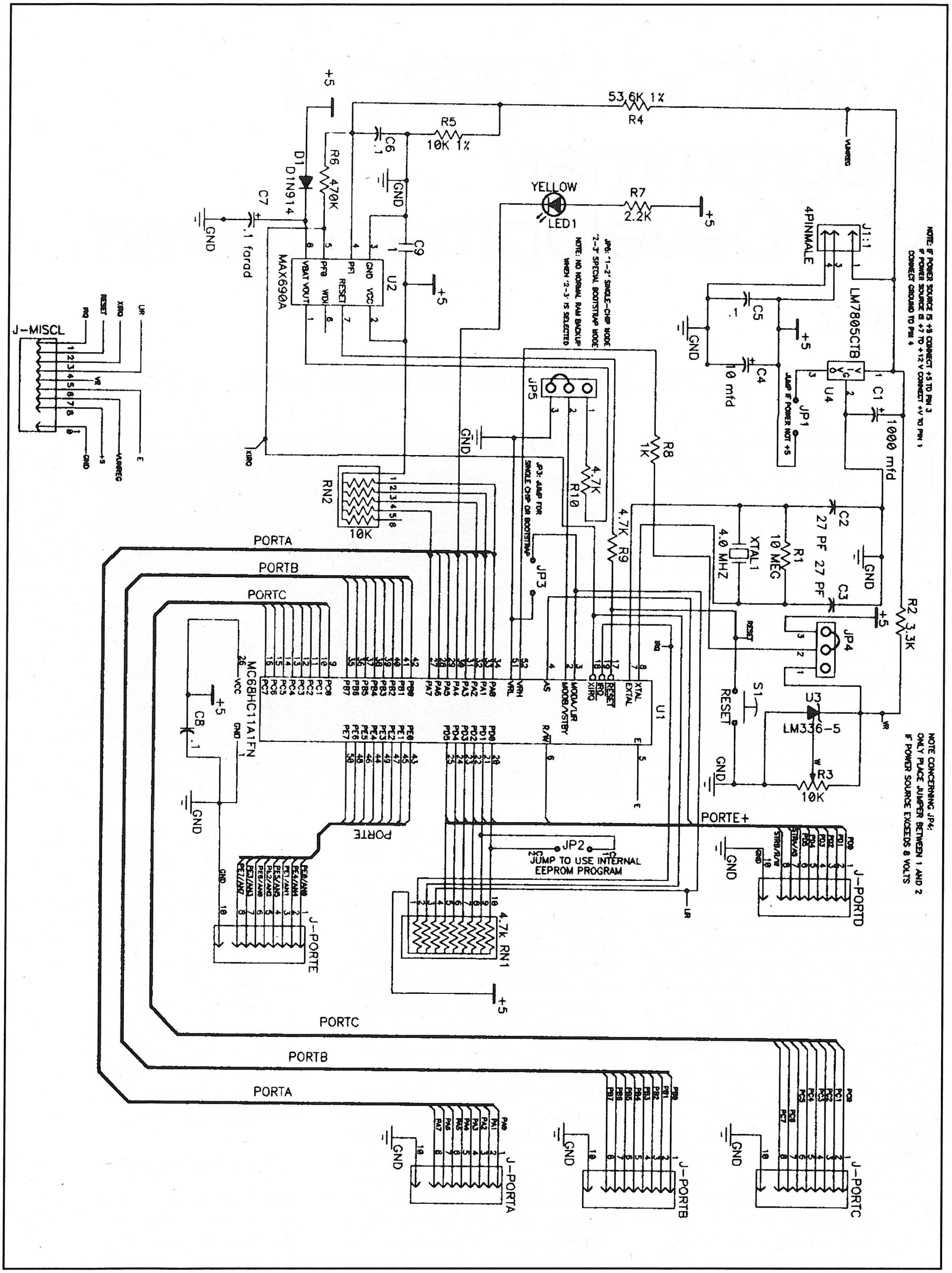


Fig. 1. Complete schematic diagram for Magtroll-II circuitry.

PARTS LIST

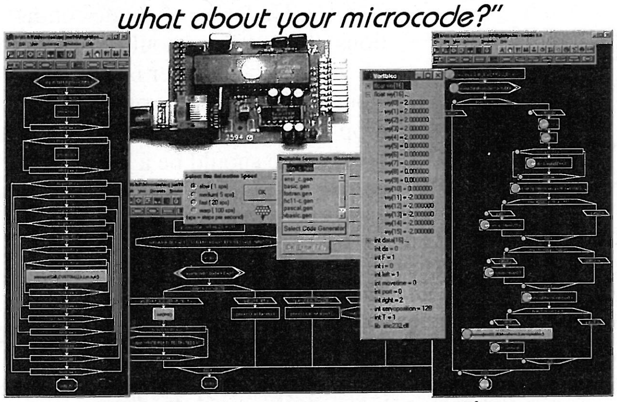
Semiconductors
D1—1N914 silicon diode
LED1—Low-power yellow light-emitting diode
U1—MC68HC11A1FN MCU or MC68HC811E2FN MCU (see text and Note below)
U2—MAX690ACPA MPU supervisor
U3—LM336-5 5-volt reference
U4—LM7805CTB +5-volt regulator

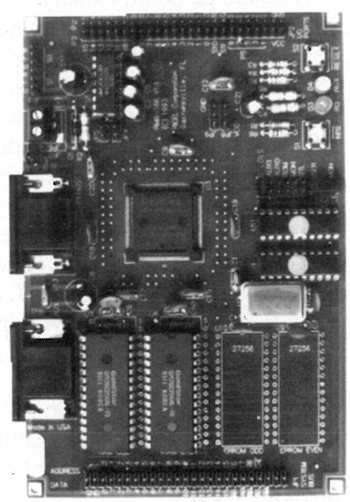
Capacitors
C1-1000-µF, 16-volt axial-lead electrolytic capacitor (see text)
C2,C3—27-pF monolithic ceramic
C4—10-µF, 16-volt radial-lead tantalum
C5 thru C10—0.1-µF monolithic ceramic

Resistors
R1—10 megohms, 1/4-watt, 5% tolerance
R2—3,300 ohms, 1/4-watt, 5% tolerance
R4—53,600 ohms, 1% tolerance
R5—10,000 ohms, 1% tolerance
R6—470,000 ohms, 1/4-watt, 5% tolerance
R7—2,200 ohms, 1/4-watt, 5% tolerance
R8—1,000 ohms, 1/4-watt, 5% tolerance
R9,R10—4,700 ohms, 1/4-watt, 5% tolerance
R3—10,000-ohm miniature pc-mount potentiometer (Digi-Key Part No. D4AA14 or Mouser Electronics Cat. No. 594-63M103)
RN1—4,700-ohm, 10-pin/nine-element bussed SIP resistor network
RN2—10,000-ohm, six-pin/five-element bussed SIP resistor network

Miscellaneous
J1—Four-pin male header, 0.1" centers (one pin removed)
J-MISCL,J-PORTA thru-J-PORTE—10-pin male header, 0.1" centers (six required; one pin removed; save two pins for TP1,TP2)
JP1,JP2,JP3—Two-pin male header, 0.1" centers
JP4,JP5—Three-pin male header, 0.1" centers
S1—Spst pc-mount switch (Digi-Key Part No. P8035S-ND or similar)
TP1,TP2—Test-point pins (removed from J-MISCL - JPORTE)
XTAL1—4.0- or 8.0-MHz crystal (see text)
Printed-circuit board, shorting plugs (jumpers), IC sockets; hookup wire; solder; etc.

Note: The following items are available from Magicland, 4380 S. Gordon Ave., Fremont, Michigan 49412: ready-to-wire pc board, $10, and PC-compatible disk, $7.10. Also available is a complete kit of parts for Mag-Magtroll-11 that contains a double-sided printed-circuit board with plated-through holes, solder mask and silk-screen; MC68HC11A1FN; all ICs; connectors; sockets; manual and PC-compatible disk (state size) with Freeware cross-assembler and documentation and BUFFALO firmware, $39. Specify un-programmed MC68H*C11A1FN, one programmed with the Test routine or one programmed for the solid-state wind-direction indicator project (described in Part 3 of this series). If no preference is stated, an un-programmed MCU will be shipped. Remember, this HC11 can easily be re-programmed with the aid of MAGPRO-11, a complete kit (described in Part 1) of which is available for $45. Please include $2.90 for shipment via Priority Mail for all orders. The MC68HC811E2FN with 2K EEPROM is *not* available as of this writing date from Magicland, but it may be available by the time you read this. Please inquire. As of this writing the MC68HC811E2FN is available for $22 each plus $4 S&H from CGN Co., 1000 Chula Vista Terr., Sunnyvale, CA 94086.





BUFFALO's Conventions

The BUFFALO monitor's ASM line assembler assumes all numbers are in hexadecimal. If you use the BUFFALO line assembler, you're restricted to hexadecimal numbers. A problem will result if you add a prefix or suffix to the number. Thus, if you type "33" while using BUFFALO's ASM line assembler, the number in decimal is actually (16 × 3) + 3, or 51! If you type "33H" or "$33" or "&H33" or any other prefix or suffix you'll receive an error message.

Table 1. Jumper Settings for Magtroll-11

JP1	Jumper if power isn't regulated 5 volts dc. If jumper is placed here, power source should be between 7 and 13 volts dc, with the positive source connected to pin 1
of	
	J1:1. Ground always connects to pin 4 of *J1:1*.
JP2	Place jumper here only if you're using Special Bootstrap mode *and* you want an immediate jump after RESET to EEPROM starting at B600H. Only use when you've installed an MC68HC11A1FN at *U1*.
JP3	If single-chip or Special Bootstrap mode is desired, place jumper here. For normal expanded mode or Special Test mode, don't install jumper. Normally, jumper should be installed here.
JP4	Jumper location here determines source of reference voltage for the MCU's internal A/D converter. If *U3* isn't installed and/or a 5-volt dc regulated power source is used, choose pins 2 and 3. Otherwise, choose pins 1 and 2. For optimum accuracy, place a jumper between pins 1 and 2, but note the restrictions.
JP5	Place jumper between pins 1 and 2 if you want normal single-chip or normal expanded mode and between pins 2 and 3 for Special Bootstrap or Special Test mode. Generally, if an HC11 is installed at *U1*, place jumper between pins 2 and
3,	and if an HC811 is used, choose pins 1 and 2.

with the aid of the actual-size etching-and-drilling guides given in Fig. 3.

Plating-through the vias that bridge the conductors from one side with those on the other side of the board is critical to proper operation. Therefore, it's highly recommended that you purchase a ready-to-wire double-sided pc board with plated-through holes and silk-screened component layout from the source given in the Note at the end of the Parts List.

If you do decide to make your own board, fabricate a single-sided version using the solder-side conductors and replacing the conductors shown for the component side with insulated wire. Make all wire connections on the solder side of the board, using thin Wire Wrap wire in all cases, except for the two jumpers shown in bold lines in the component-side artwork in Fig. 3, which should be a minimum of 22-gauge hookup wire.

Wire the pc board exactly as shown in Fig. 4. Notice that all 10-pin male header connection blocks have pin 9 removed for polarizing purposes. (Save two of these pins for test points *TP1* and *TP2*.) Polarization reduces the chances of connection errors. Be sure to place a keying/polarizing plug at the pin-9 location of all cable sockets that will mate with the connectors on Magtroll-11. Also, since *J1:1* has pin 2 removed, insert a keying/polarizing plug at this location of its respective socket.

A PLCC socket at location *U1* increases Magtroll-11's versatility. A socket for *U2* is optional but highly recommended.

Axial-lead capacitor *C1* mounts vertically to conserve precious pc-board real estate. Exercise care when installing *C1*. Use insulating tubing on the long bare lead to obviate any possibility of a short circuit to other nearby components and use a bead of fast-setting epoxy cement or hot-melt glue to hold *C1* firmly in place. If you wish to avoid potential electrical problems, you can substitute a 330-µF radial-lead capacitor here with only minor performance restrictions.

If you omit *C7*, there will be no "normal" RAM back-up. For longer RAM back-up, you may want to increase the value of *C7* to 1.0 or even 3.3 Farad. However, you may have to rig something to accommodate the larger physical size of these capacitors on the pc board.

Do *not* install ICs at the *U1* and *U2* locations until requested.

Preliminary Tests

Magtroll-11 has been fully tested at 1 MHz. It also should work properly at 2 MHz. For 2-MHz operation, replace *XTAL1* with an 8-MHz crystal. It may also be necessary to reduce the values of *C1* and *C2* to 22 or even 15 pF.

Connect a suitable dc power source to via *J1:1*. If the source is regulated 5 volts dc, connect the positive (+) conductor to pin 3 and do *not* connect jumper at *JP1*. If the power source is unregulated and between 7 and 13 volts dc, connect the + conductor to pin 1 and place jumper at *JP1*. In either case, connect the ground conductor to pin 4 of *J1:1*. If the output from the power source exceeds 8 volts, jumper pins 1 and 2 of *JP4*. If it doesn't, jumper pins 2 and 3 of *JP4*.

Clip the common (–) probe of a dc voltmeter or a multimeter set to the dc-volts function to the test point JP2/GND. After applying power to the circuit, use the "hot" probe to measure the voltage at TP1/+5, pins 26 and 52 of the *U1* location and pin 2 of the *U2* location. You should obtain a reading between 4.75 and 5.25 volts at all three locations. If the power source exceeds 8 volts, adjust *R3* so that the pin-52 location of *U1* registers 5.00 volts. (To simplify design, you may want to readjust *R3* at a later time for a 5.12-volt reading at pin 52 of *U1*. With this reference voltage, each A/D input bit will correspond to 0.02 volt.)

When you obtain the proper readings, power down and install MAX-690 *U2*. Reapply power and check pin 7 of *U2*. Under steady-state conditions, this reading should be close to +5 volts. When power is removed from the circuit, this voltage should drop quite fast, and when power is applied, there should be a slight delay before this reading suddenly reaches nearly +5 volts.

Jumper Settings

The functions of the jumpers on Magtroll-11 are as follows:

JP1 sets up the type of power source.

JP4 is used to select the type of reference voltage (standard +5 volts or, more accurately, that produced by *U3*).

JP3 and ***JP5*** select MCU operating mode.

JP2 causes an immediate jump to B600H when Special Bootstrap mode is selected.

Refer to Table 1 for appropriate jumper set-up.

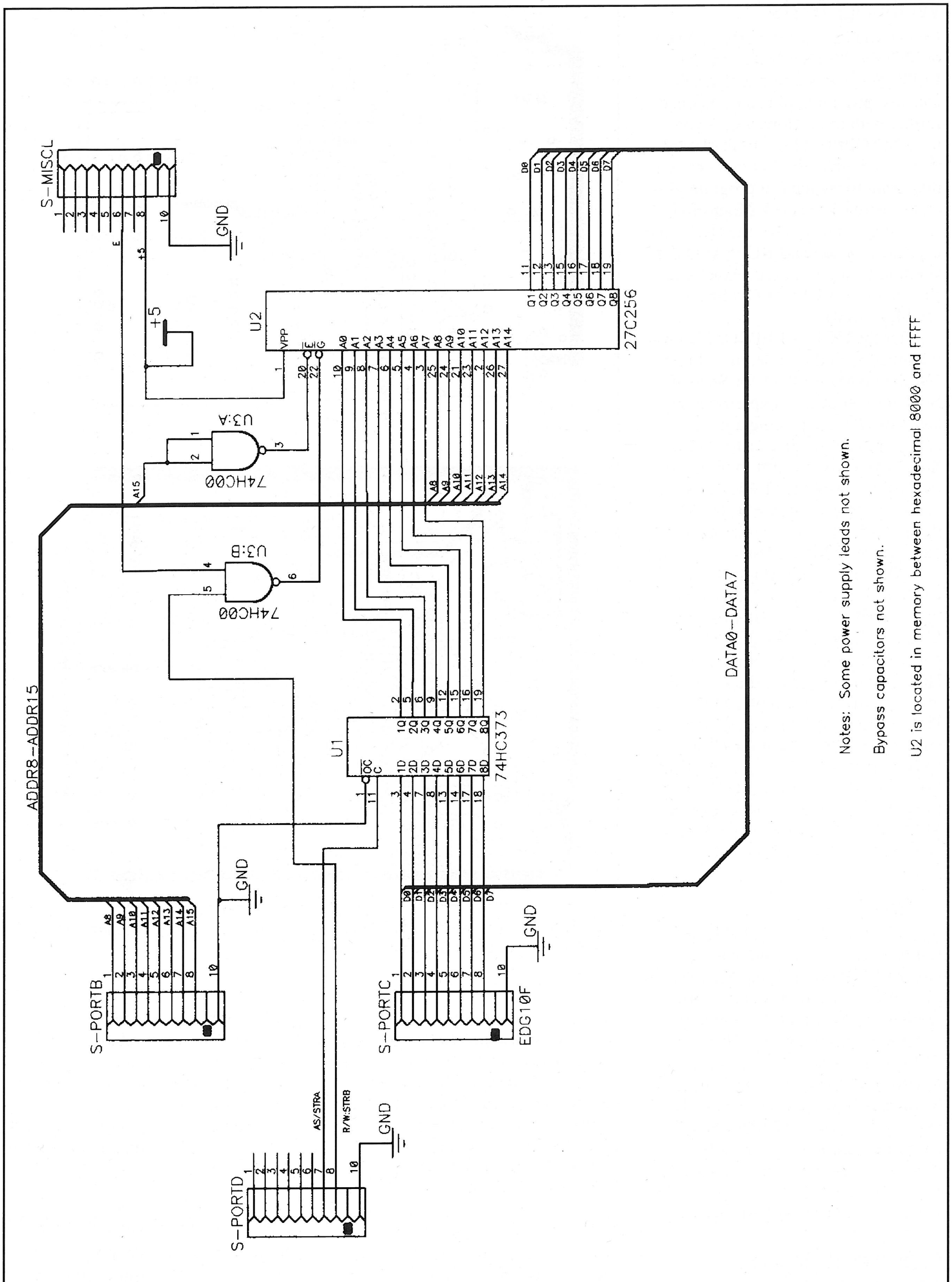


Fig. 2. Schematic diagram for Magtroll's expansion-board circuitry.

Working Tests

Unless you have a MC68HC11A1FN or MC68HC811E2FN that has its EEPROM programmed with a suitable test program, you can't proceed further with tests. However, if you have MAGPRO-11 or similar board that uses the BUFFALO monitor, you may want to try the test program given in Listing 1 to check Magtroll-11.

Listing 1 is meant for the HC11 and is printed in standard BUFFALO convention. It can be entered exactly as shown, using BUFFALO's line assembler (ASM).

After the HC11's EEPROM is programmed with this code, install it at *U1*. Set up Magtroll-11 for Special Bootstrap mode by jumpering pins 2 and 3 of *JP5* and placing a jumper on *JP3*. A jumper on *JP2* instructs the Special Bootstrap ROM to jump immediately to B600H (Table 1). After power is applied, the LED should flash at a 1-second rate (0.5-second rate with an 8-MHz crystal).

If you wish to test Magtroll-11 with an HC811, use Listing 2. Programming an HC811 using BUFFALO Monitor Version 3.4 is slightly more complicated than programming an HC11. You must place the programming boards (for example, MAGPRO-11) into Special Test mode and change the data at location 103FH to FFH with Memory Modify command MM. You also must use BUFFALO's EEMOD command to ensure that the EEPROM is located between F800H and FFFFH. This is done with the command:

```
EEMOD F800
```

In general, while the MC68HC811-E2FN is easier to use and has a much larger EEPROM, than the MC68HC-11A1FN, it's more difficult to program using the BUFFALO monitor.

After programming the HC6811 EEPROM, install it at *U1*. Set up Magtroll-11 for single-chip operation by installing jumpers at *JP3* and between pins 1 and 2 of *JP5*. There's no need to install jumper at *JP2*. If everything is working properly, the LED should flash at a 1-second rate (0.5-second rate with an 8-MHz crystal).

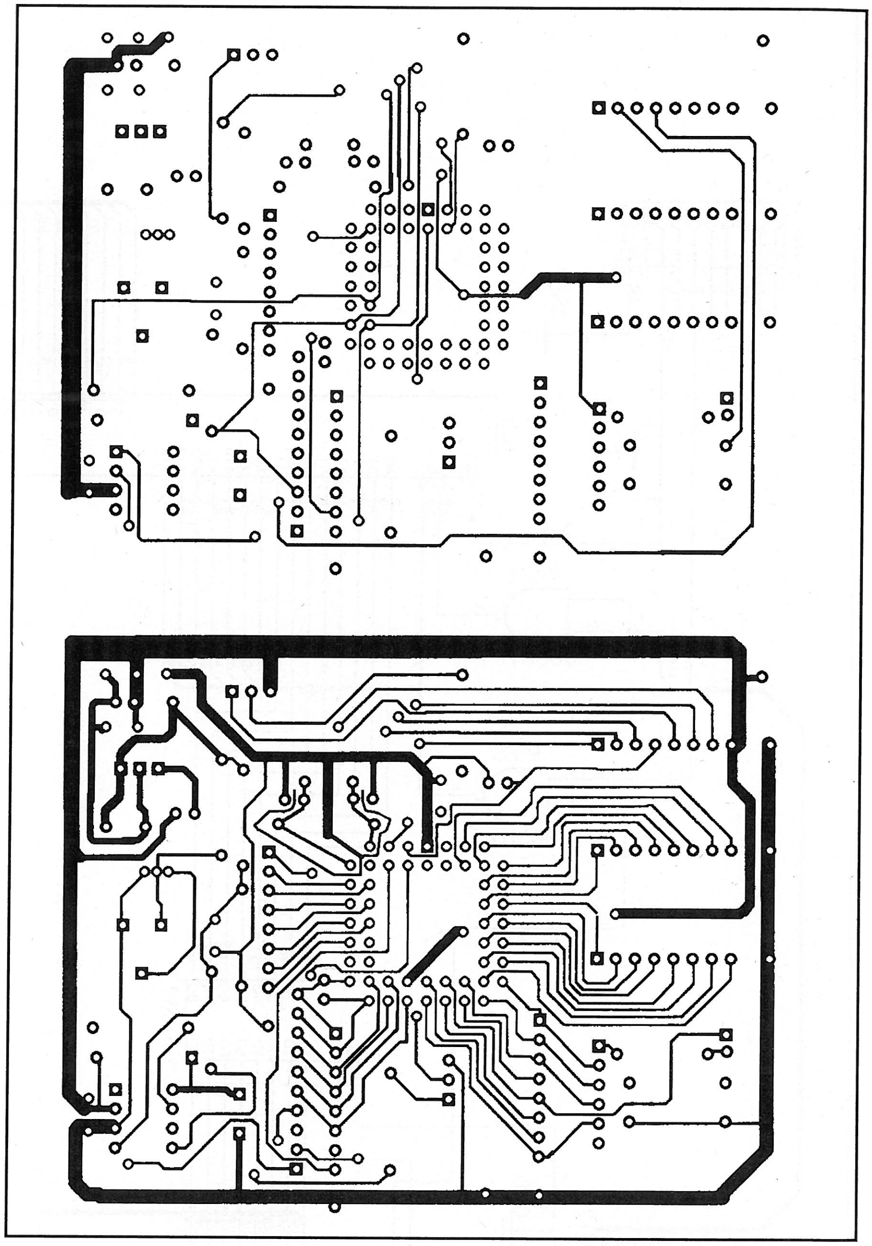


Fig. 3. Actual-size etching-and-drilling guides for component (upper) and solder (lower) sides of Magtroll's printed-circuit board.

Connecting to Magtroll-11

To connect to Magtroll-11, you need 10-contact, single-row connectors with 0.1" spacing. A keying plug is recommended at pin 9 for polarization. I've used AMP MT connectors, sources for which include Digi-Key Corp. and Mouser Electronics. For each connector, you need a 10-position single-row MODU Housing (AMP No. 1-87499-7, Digi-Key No. A3019-ND, Mouser No. 571-1874997); nine contacts (AMP #87667-3, Digi-Key #A3000-ND, Mouser #571-876673); keying plug (AMP No. 86286-1, Digi-Key No. A3077-ND, Mouser No. 538-15-04-9209); and suitable cable. Special-purpose tools are available to crimp the wires to the contacts, but with care, you can use long-nose pliers and a soldering iron.

When connecting to J-PORTE, make special note of its odd pinout arrangement. Refer to Fig. 1 and Fig. 4.

Using Internal EEPROM

Motorola designed the original MC-68HC11 for use in single-chip circuits. The program that controls the application was stored in the chip's

internal 8K ROM. The 512-byte EEPROM was primarily meant to be used to store information that had to be changed only once or, at most, a few times, although it can be changed more than 10,000 times.

The need in certain circumstances to have a way to force the MCU to jump directly into EEPROM after reset was anticipated by the designers. This enables a simple single-chip system to make use of the 512-byte EEPROM for program storage. Since the EEPROM's starting address is at B600H, the jump must be directly to this address after reset.

Normally, the HC11 jumps to the address pointed to the vector located at address FFFEH and FFFFH. For instance, if the address FFFEH contains B6H and FFFFH contains 00H, under normal operation, the MCU would jump to the address B600H. However, in a simple single-chip system using the standard MC68HC11A1FN, there's no external memory at FFFEH and FFFFH. The solution was to automatically cause the jump to start of EEPROM under two easily-met conditions.

The first condition was that the chip had to be in Special Bootstrap mode, accomplished by placing a ground potential at pins 2 (MODB) and 3 (MODA) of the MC68HC11A1FN at time of reset. (If you simply ground these pins, it isn't possible to use the battery-backup feature of the chip's internal RAM since pin 2 also functions as a battery-backup voltage source.) The second condition is that pins 20 and 21 had to be tied together. However, doing this makes it impossible to make use of the asynchronous serial interface. So you can see that there could have been a less-problematic solution here. However, other general-purpose solutions would likely cause a slightly greater chip cost.

With Magtroll-11, an automatic jump to EEPROM at B600H occurs at reset when *JP2* and *JP3* are installed and positions 2 and 3 of *JP5* are jumpered.

Unlike the original 68HC11, the MC68HC811E2FN was designed for program code to be contained within its 2K EEPROM. It comes with its 2K EEPROM located between F800H and FFFFH. With this chip, you don't have the problems associated with the original HC11. You can place it in

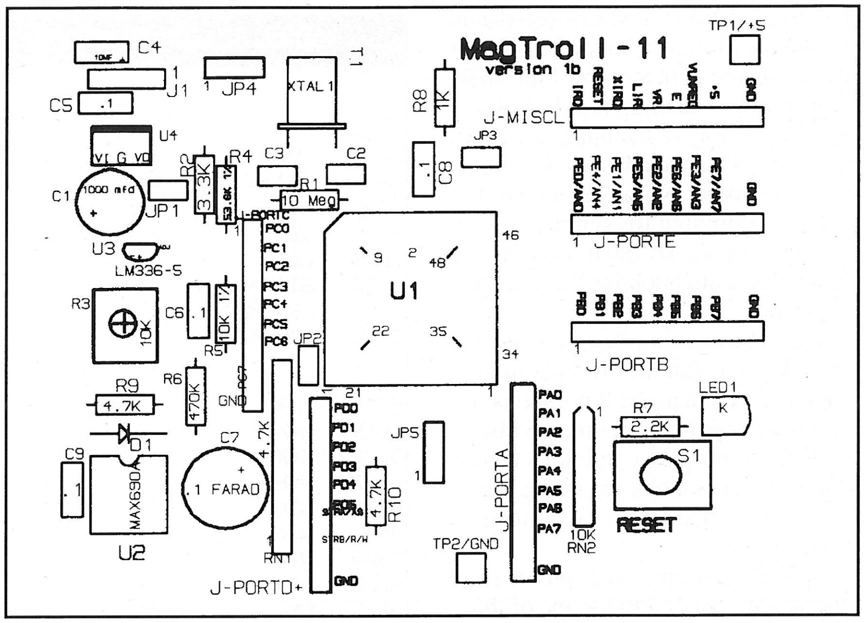


Fig. 4. Wiring guide for pc board.

single-chip mode and the starting address of the program (typically F800H) at its reset vector (located at FFFEH and FFFFH).

If you're using an HC811, don't install jumpers at *JP2* and *JP3*, but do jumper positions 1 and 2 of *JP5*. Also, make sure the starting address of your program is stored at the reset vector's address of FFFEH and FFFFH. The memory map for the EEPROM is changeable, accomplished by modifying the chip's CONFIG register located at 103FH. Refer to Part 1 for more details concerning this little-used feature.

Interrupt Vectors

Like the original 6800, the HCx11 uses a reset vector to point to the starting address. This is contained in the last two bytes of the memory space (FFFEH and FFFFH). Also, unlike the 8051 series, this is a true vector, with the data stored at these addresses corresponding to the starting address. You don't use a JUMP or similar instruction because the HCx11 automatically causes a jump to this location. (The most-significant byte of the address is stored at FFFEH, and the least-significant byte is stored at FFFFH.)

Since the 8051 was made somewhat downward software-compatible with

Motorola Freeware's HC11 Cross-Assembler

If you want to use Magtroll-11 in a unique project you designed yourself, you should have a suitable cross-assembler. While C compilers and other advanced languages are available for the HC11, Magtroll-11's limited program memory (512 to 2K bytes) makes assembly language a necessity.

Happily, there's a satisfactory cross-assembler that is essentially free. Motorola operates a free electronic bulletin board that can be reached by dialing 512-891-3733. The Freeware has been divided into several different BBSes. The one of interest here is AMCU BBS. This and the other BBSes provide an abundance of information—all for the price of a phone call to Texas. The protocol is eight data bits, no parity, one stop bit. The BBS handles a variety of baud rates, the maximum of which is continuing to increase. Of course, Motorola supports and probably will continue to do so the popular 2,400-baud rate.

In this installment, you're primarily interested in HC11 cross-assemblers. IBM users want the files as11.exe or as11new.exe (similar to as11.exe but with cluster fix and other enhancements) and document files asref.man and asrefnew.man. MAC users want mac11 and macasm.doc. The IBM versions of cross-assembler and documentation are also available on disk. See the Note at the end of the Parts List.

the original MPU, it seems reasonable to believe Motorola learned a bit from the perceived deficiencies of the 8080. Apparently, one thing it didn't like was Intel's way of handling interrupts.

Table 2 lists the all-important vector assignments, with register and local masks omitted for simplicity. Consult Motorola's MC68HC11A8/D Technical Data book for this and other pertinent information.

Table 2 makes it obvious to even an Intel devotee that the HC11 is more-sophisticated than the 8051 series. If you have any doubts, compare this table to a similar one in Intel's Microcontroller Handbook regarding the 8051 series. It shows only six interrupt sources!

Though descriptions of all interrupt sources are beyond the scope of this article, I'll cover the Illegal Opcode Trap, COP Failure and COP Clock Monitor because they're interesting and, more importantly, their appropriate use adds to system reliability. Keep in mind the meaning of these interrupt vectors. For example, say the MCU receives a valid IRQ on pin 19 and D0H is stored at FFF2H and 00H at FFF3H. The MCU automatically jumps to address D000H when it receives the IRQ. Other vectors are handled similarly. (Certain other conditions, such as the clearing of the Condition Code Register's I bit, must be met.)

You may notice a little problem if all you use is an HC11's 512-byte EEPROM for program storage—no usable memory at the addresses listed in Table 1. Motorola provides Bootstrap Mode Pseudo-Vectors, located in internal RAM. These RAM locations are referred to as pseudo-vectors since they can be used like vectors to direct control to interrupt service routines. However, it's extremely important to keep in mind that each pseudo-vector is allowed three, rather than only two, bytes of memory. Three bytes are needed because, unlike true vectors, you must add an explicit JUMP (JMP or $7E) opcode to cause the desired jump. Table 3 lists these pseudo-vectors.

Notice that the address for Reset stands out prominently from the rest. Unlike the other addresses, BF40H isn't located in internal RAM (0 through FFH). Rather, it's located in the Bootloader ROM (normally between BF40H and BFFFH) that's contained in all HC11 chips.

This short boot loader firmware, enabled whenever the HC11 is started in Special Bootstrap mode, has a number of features that are beyond the scope of this article. One I've already mentioned concerns you. If the bootloader determines that PD0/RxD and PD1/TxD (pins 20 and 21) are connected together, it automatically causes a jump to the start of EEPROM at location B600H. (If you're

Listing 1. LED1 Flasher Test Program for MC68HC11A1FN

(Convention Used: BUFFALO)

```
B600   LDS         #00B0
B603   LDAA        #10
B605   STAA        1000
B608   JSR         B622
B60B   CLRA
B60C   STAA1000
B60F   JSRB622
B612   BRAB603
...............
...............
B622   LDX         #E700
B625   NOP
B626   NOP
B627   NOP
B628   NOP
B629   NOP
B62A   NOP
B62B   DEX
B62C   BNE         B625
B62E   RTS
...............
...............
```

Listing 2. LED1 Flasher Test Program For MC68HC811E2FN

(Convention Used: BUFFALO)

```
F800   LDS         #00B0
F803   LDAA        #10
F805   STAA        1000
F808   JSR         F822
F80B   CLRA
F80C   STAA        1000
F80F   JSR         F822
F812   BRA         F803
................
................
F822   LDX         #E700
F825   NOP
F826   NOP
F827   NOP
F828   NOP
F829   NOP
F82A   NOP
F82B   DEX
F82C   BNE         F825
F82E   RTS
................
................
```

For the following two bytes use Buffalo's Memory Modify command (MM) and *not* the ASM:

```
FFFE   F8
FFFF   00
```

interested in technicalities, after initializing the SCI and Port D, the bootloader in the HC11 looks for the FFH character that determines the baud rate for the download. If a break character is received, instead of FFH, an immediate jump to B600H at the start of EEPROM is executed. It may appear that the same thing can be accomplished by tying PD0/RxD to a ground, but this doesn't work because a high-to-low transition is required to indicate the beginning of a start bit.

As an example of how to use these pseudo-vectors, assume you have an interrupt service routine that starts at B700H you wish accessed when the chip receives a valid IRQ signal at pin 19. The pseudo-vector of interest starts at 00EEH and ends at 00F0H in RAM (see Table 2). (Don't refer to Motorola's HC11 Reference Manual since it erroneously lists the address as 00EEH to 00FDH.) You want JMP opcode 7EH stored at 00EEH, address B7H stored at 00EFH and 00H stored at 00F0H.

Unless you have absolute confidence in your RAM back-up power source, don't rely on programming RAM after construction and then forgetting about it. You'll most likely have problems. The best solution is to write a short subroutine and place it at the beginning of your code in EEPROM. The program segment given in Listing 3 will accomplish this.

Table 2 HCx11 Interrupt Vector Assignments

Vector Address (Hex)	Interrupt Source
FFC0, C1	Reserved
*	*
*	*
FFD4, D5	Reserved
FFD6, D7	SCI Serial System
FFD8, D9	SPI Serial Transfer Complete
FFDA, DB	Pulse Accumulator Input Edge
FFDC, DD	Pulse Accumulator Overflow
FFDE, DF	Timer Overflow
FFE0, E1	Timer Output Compare 5
FFE2, E3	Timer Output Compare 4
FFE4, E5	Timer Output Compare 3
FFE6, E7	Timer Output Compare 2
FFE8, E9	Timer Output Compare 1
FFEA, EB	Timer Input Compare 3
FFEC, ED	Timer Input Compare 2
FFEE, EF	Timer Input Compare 1
FFF0, F1	Real Time Interrupt
FFF2, F3	IRQ (External Pin or Parallel I/O)
FFF4, F5	XIRQ Pin (Pseudo Non-Maskable Interrupt)
FFF6, F7	Software Interrupt (SWI)
FFF8, F9	Illegal Opcode Trap
FFFA, FB	COP Failure (Reset)
FFFC, FD	COP Clock Monitor Fail (Reset)
FFFE, FF	RESET

Keeping It Alive

Magtroll-11 uses two schemes for internal RAM back-up. First, when the potential drops below about 4.65 volts 0.1-Farad (or larger) super-capacitor *C7* takes over as the RAM's energy source to provide back-up power for quite a period of time, usually much longer than calculations would assume. With Magtroll-11, it isn't possible to use this means of RAM back-up if Special Bootstrap or Special Test mode is used.

The other back-up system is more sophisticated, although it's a bit strange since it occurs when the power supply is dying from a power failure or disconnection. It uses the HC11's STOP instruction that causes all clocks to stop, reducing consumption to a few microamperes. In addition to reset and back-up source switch-over capability, the MAX690 has a power-failure detector. Along with *R4*, *R5*, *R6* and *C6*, it triggers an interrupt at PFO pin 5 when PFI pin 4 detects that the raw power supply (before voltage regulator *U3*) is starting to fail. In Magtroll-11 this triggers a pseudo-nonmaskable interrupt XIRQ. What occurs then depends upon the firmware. Generally, XIRQ points to a service routine that includes the STOP opcode. A sample code segment might be:

```
        *
        *
* REM: XIRQ RECEIVED; STOP ALL
CLOCKS
        NOP
        STOP
        RTI
        *
        *
```

As its name indicates, XIRQ isn't a true non-maskable interrupt. It can be masked with the X bit in the Condition Code Register (CCR). Also, after reset, the X bit is set, which means that the XIRQ input isn't enabled immediately after reset. To enable it and the STOP instruction, clear the bits in the CCR shortly after initializing the stack pointer. The following program segment accomplishes this:

```
        *
        *
        CLRA
        TAP
        *
```

If you wish to experiment a bit with XIRQ and the STOP instruction using the MC68HC11A1FN, try Listing 4, which again assumes you'll be using the BUFFALO monitor. This short program initializes XIRQ in RAM so that the program jumps to the XIRQ service routine that starts at B700. It then flashes on and off the LED to verify everything is working okay. Next it checks RAM location 10H. If 6FH is stored at 10H, the LED lights and the program then pauses (WAI instruction) and waits for an interrupt. If other data (anything but 6FH) is stored at 10H, the LED is off and the program waits for an interrupt. If an XIRQ is detected, the XIRQ service routine stores 6FH at 10H and then executes the STOP instruction.

(Continued on page 103)

By Tom Benford

Upgrading: The Quest For Multimedia Nirvana

What multimedia is, why you need it and gearing up to obtain the best there is

Multimedia is here big-time, and it has gained lots of momentum along the way—far in excess of what any of the industry pundits originally predicted. While there were only a handful of multimedia-ready systems and upgrade kits available just a couple of years ago, multimedia-ready PCs and upgrade kits now abound. Indeed, having a multimedia-capable PC is a prerequisite if you want to run any of today's (not to mention tomorrow's) software.

Photos, Videographs & Tables By Tom Benford

To reach multimedia Nirvana there are three distinct ways to go: upgrade your existing PC to multimedia capability, purchase an off-the-shelf multimedia system or build one from scratch using individual components. These choices can be a mixed blessing. Though you have plenty of options from which to choose, deciding what's best for you can be confusing.

In this article, I'll explore each of these paths to help you decide which one you'll take. Before you make a move, however, it's important that you fully understand what "multimedia" currently means with regard to hardware requirements.

Multimedia PC Specifications

The Multimedia PC Marketing Council, a subsidiary of the Software Publishers Association, was founded to provide a set of standard specifications that define the requirements for multimedia on IBM/compatible per-

Table 1. Differences Between MPC Levels 1,2 & 3 Specifications

Requirements	MPC Level 1	MPC Level 2	MPC Level 3
RAM	2MB	4M	8M
Processor	16MHz 386SX	25-MHz 486SX	75MHz Pentium or equivalent. *The CPU must pass the MPC Test Suite. The MPC Test Suite is benchmarked on a 75MHz Pentium Processor with only level one cache; this specification is not intended to exclude other microprocessor brands or architectures from compliance as long as they pass the MPC Test Suite.*
Hard Drive	30MB	160M	540M
CD-ROM Drive	150K/s sustained transfer rate, maximum average seek time 1 second	300KB/sec. sustained transfer rate, maximum avg. seek time 400 milliseconds, CD-ROM XA ready, multisession capable	600K/s sustained transfer rate, avg. access time of 250ms; CD-ROM XA ready, multisession capable
Sound	Eight-bit digital sound, eight-note synthesizer, MIDI playback	16-bit digital sound, 8 note synthesizer, MIDI playback	16-bit digital sound, wavetable, MIDI playback; if speakers are included, they must be measured and tested at minimum of 3 watts/channel.
Video	640x480, 16 colors	640 x 480, 65,536 colors	MPEG1 (hardware or software) with OM-1 compliance; direct access to frame buffer with a resolution of 352x240 at 30 fps (or 352x288 at 25 fps) at 15 bits/pixel, unscaled, without cropping; all codecs (hardware and/or software) must support a synchronized audio/video stream with a resolution of 352x240 at 30 fps (or 352x288 at 25 fps) at 15 bits/pixel without dropping a frame.
Graphics Performance	N/A	Delivery of 1.2M Pixels/s given 40% of CPU bandwidth	Color space conversion and scaling capability; direct access to frame buffer for video-enabled graphics subsystem with a resolution of 352x240 at 30 fps (or 352x288 at 25 fps) at 15 bits/pixel, unscaled, without cropping.
Ports	MIDI, joystick, serial, parallel	MIDI, joystick, serial, parallel	MIDI, joystick, serial, parallel
User Input	N/A	101 key IBM-style keyboard or keyboard that delivers same functionality; two-button mouse	101 key IBM-style keyboard or keyboard that delivers same functionality; two-button mouse
System Software	*Windows* 3.0 plus Multimedia Extensions	*Windows* 3.0 plus Multimedia Extensions or binary compatible	*Windows* 3.11 and DOS 6.0 or binary compatible

Note that above requirements are ***minimum*** and not a recommendation by Multimedia PC Marketing Council for a particular system configuration. Complete information regarding specifications is available from Multimedia PC Marketing Council, 1730 M Street NW, Ste. 707, Washington, DC 20036-4510 (tel.: 202-452-1600, ext. 330; fax: 202-785-3197 or mpc.info@spa.org).

sonal computers. The intention was to establish a standard multimedia computing platform as an extension of the desktop PCs already in use by millions of people. The resulting standard, known as MPC Level 1, has since been adopted around the world.

The original Multimedia PC (MPC) specification was adequate for hardware current at the point in time it was drafted in 1990. It fell woefully short in light of advances made in PC technology since then.

In May, 1993, a revised standard known as MPC Level 2 was published by the Multimedia PC Marketing Council as an enhanced multimedia computer standard that's more consistent with the hardware required to obtain the kind of performance everyone now wants (and expects) from multimedia products. While still in wide use and quite popular, this measurement standard for multimedia equipment performance is quickly becoming dated, especially with Pentium-based machines that incorporate quad-speed drives and PCI video.

As with Levels 1 and 2, the performance standards have advanced and will continue to evolve as better and faster CPUs, operating systems, CD-ROM drives and audio and video systems are developed and put into computer systems by all major manufacturers.

One of the driving forces behind upgrading the standard is achieving fluid, full-screen, full-motion video comparable to VHS videotape. The MPEG1 standard has become the widely-accepted means of achieving this end, as evidenced by the MPC3 standard.

In mid-June of 1995, the MPC Marketing Council released the MPC3 standard that pushes the envelope for hardware/software performance still further, in keeping with current technology advances in the world of multimedia. It's important to note that the Level 1 specification continues in full effect, and, unless *all* Level 2 requirements are met, the system is considered a Level 1 machine. Likewise, unless *all* Level 3 requirements are met, the system may be classified as a Level 2 machine. Table 1 illustrates the differences between MPC Levels 1, 2 and 3 specifications.

As you can see, things have come a long way in just a few short years, so much so, in fact, that the 80386 CPU has become virtually obsolete and even the low-end 80486 CPU is now *passé*, especially at the low prices entry-level Pentium-based systems are being offered by many major vendors.

Table 2. Norton System Information Benchmark Ratings

System	CPU	CPU Rating	Disk Rating	*Norton* Index
Packard-Bell	Intel Pentium,100 MHz	316.2	14.6	215.0
Swan	Intel Pentium, 75 MHz	237.9	13.5	163.1
MicroFLEX-586	**Cyrix 586, 100 MHz**	**227.0**	**21.6**	**158.4**
NEC Express II	Intel Pentium, 60 MHz	190.3	13.7	131.2

This table shows how the MicroFLEX-586 with its Cyrix 586 100-MHz CPU stacks up against genuine Intel Pentium-based systems using the System Information benchmark program of Norton *Utilities*.

CPU, Motherboards & Other Components

While a low-end, 25-MHz 486SX chip will run circles around a 33-MHz 386DX, it pales by comparison when compared to Pentium CPUs. The best way to illustrate this is via the Table 2 comparison chart provided courtesy of Computer Product Testing Services Inc.(Manasquan, NJ). For comparison purposes, Table 2 shows the elapsed time required to morph 110 frames on various PC platforms, all using the same source images and frame settings. To keep the comparison "level," all test systems were equipped with 8M of RAM running *Windows* 3.11. Gryphon's *Morph* 2.5 was used as the application software for this benchmark series.

If your present system is based on an 80386 chip, you should seriously consider a CPU upgrade. You may be able to squeak passable performance out of a 33-MHz 386 for word-processing and spreadsheet chores, but this system is never going to have the power and speed required for even the most mundane multimedia application. Bear in mind that as multimedia applications continue to become more sophisticated and the demands on the CPU and other system components become more intense, the barest minimum of a DX2/66 486 or Pentium-based CPU makes sense to consider at the present time.

Some system motherboards permit replacing an 80386-genre CPU with one of the 486 varieties. While not all 386 motherboards permit an upgrade, performing one on those that do typically consists of changing some jumper settings on the board, swapping out the CPU chip and replacing the oscillator crystal that controls the timing of the system and keeps it in sync with the CPU's clock cycles.

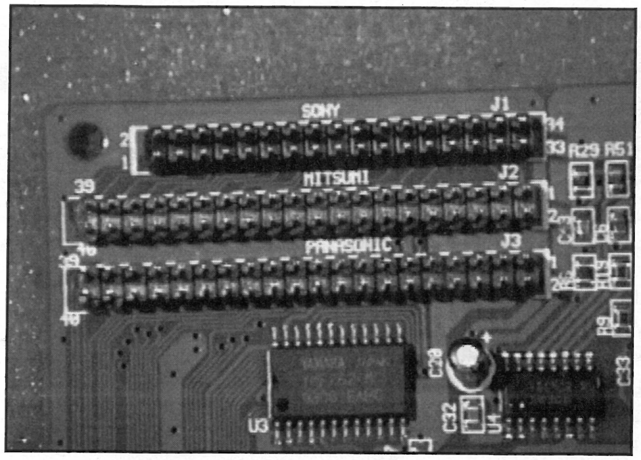
If your motherboard supports an upgrade, this is the easiest and least-expensive way of obtaining more CPU horsepower under your hood. You can buy a 486 CPU for less than $100 for an SX25, and a Pentium 60-MHz CPU for less than $200.

You may also want to consider using a Cyrix 586 CPU, rather than an Intel Pentium. Performance is comparable, but the price tag is significantly less for the Cyrix chip. This CPU will work on many 486 motherboards (and possibly some older 386 motherboards) that won't accommodate an Intel Pentium.

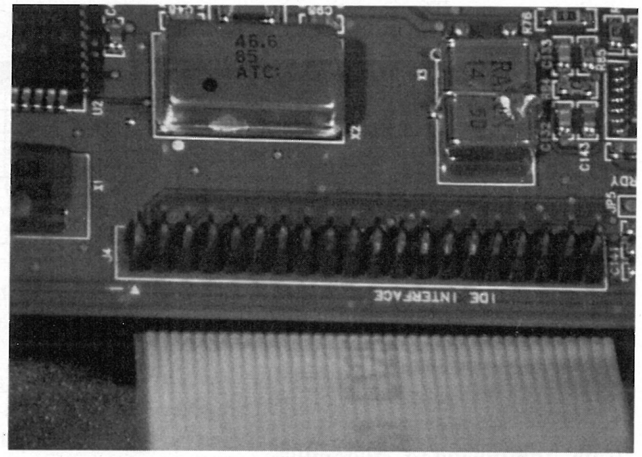
Be sure to check the owner's manual that came with your system or call the manufacturer to find out if your motherboard can accept a CPU upgrade. In general, motherboards designed for 386/486 CPUs can't accommodate a Pentium CPU because of the difference in size and pin pattern. You can buy Pentium motherboards for $200 or less without CPU. Some suppliers offer a trade-in allowance for your 386/486 CPU, further lowering the cost of upgrading.

For 386 or 486 owners who are interested in moving right up to Pentium power (a wise choice), upgrading the whole motherboard may be the most cost-effective and logical way to go, since other components of the system will function just fine with the additional speed and muscle provided by the Pentium chip. There are several sources of low-priced motherboards, complete with Pentium CPUs in various "flavors" that make this an attractive alternative to consider.

By upgrading the motherboard with CPU, you recycle all (or most) of the other system components, such as RAM SIMMs, floppy and hard drives, system-unit enclosure with power



Many sound cards, such as this Oak Mozart, also provide multiple CD-ROM interfaces. Even though the Mitsumi and Panasonic headers both have 40 pins, they aren't interchangeable. Correct orientation of the tracer on the ribbon cable to pin 1 of the header is also essential for the drive to work.



A small solid triangle denotes pin 1 on the SoundBlaster 16's IDE interface connector. It's essential to get the correct orientation of tracer side of the ribbon cable toward pin 1. Also, be sure to attach the connector securely by pushing it all the way down, making sure you don't miss or bend any pins when attaching it.

supply, video monitor and other items. If you decide to upgrade the motherboard, it's best to select one that has most of the essential components—such as the IDE drive interface, serial and parallel ports—integrated into it. This saves the expan- sion slots for installing other peripheral items.

Since most multimedia applications are so video-intensive, it's also a good idea to get a motherboard that has integrated local-bus video or, better yet, a PCI video bus. The benefit is greatly increased video-processing speed, which is a must for smooth full-motion video in multimedia.

Other Multimedia Necessities

Aside from a motherboard, system-unit enclosure and power supply, there are a number of other items to which you must give serious consideration. Among these are:

• **RAM.** If the CPU is the heart of the machine, RAM is the blood of the beast. While virtually all PCs shipping today come with 4M of RAM installed, this is really just a base configuration. To obtain good multimedia performance, you want at least 8M of RAM, with 12M to 16M highly desirable. *Windows* 3.1 can effectively get by with 8M, but if you'll be upgrading to *Windows 95* or *Windows NT*, you'll be able to access and use as much RAM as your motherboard can hold—the more the better.

I've also found that having an abundance of RAM is always a blessing. The extra RAM can be used as a RAM disk, which comes in handy for doing video captures and working with large, multi-track audio files when preparing multimedia presentations. Of course, you can also allocate any excess RAM as additional virtual workspace, using some of the better memory-management products available. As with CPU speed and muscle, you can't have too much RAM.

• **Hard-Disk Storage.** 200M and larger-capacity drives are considered banal these days, as are access times greater than 20 ms. The rule of thumb here is to upgrade to a drive that has as large a capacity and is as fast as your wallet will permit. In many cases you can just add a second hard drive to your existing setup to gain the additional storage space.

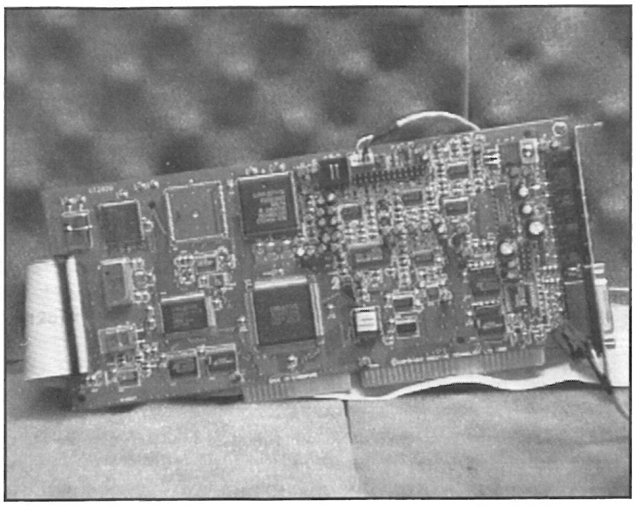
Capturing full-motion video and CD-quality audio in 16-bit, 44.1-kHz format takes lots of storage space. So half-gigabyte and larger-capacity drives aren't as excessive as they may at first seem to be. IDE and SCSI drives offer the best combination of price and performance. If your CD-ROM drive uses a SCSI interface, you'll also be able to daisychain a SCSI hard drive using the same interface card.

• **Fast Video.** If you don't already have a video adapter capable of super VGA (800 × 600 at 256 colors) with at least 1M of video RAM, you're way behind the times. Upgrading your video to current standards should be another item on your upgrade shopping list. Most multimedia applications, particularly those that incorporate full-motion video, are designed to run with a minimum palette of 256 colors. Hi-color cards that support 32K or 64K colors are even better, but these extended palettes aren't always available at higher screen resolutions like 1,024 × 768).

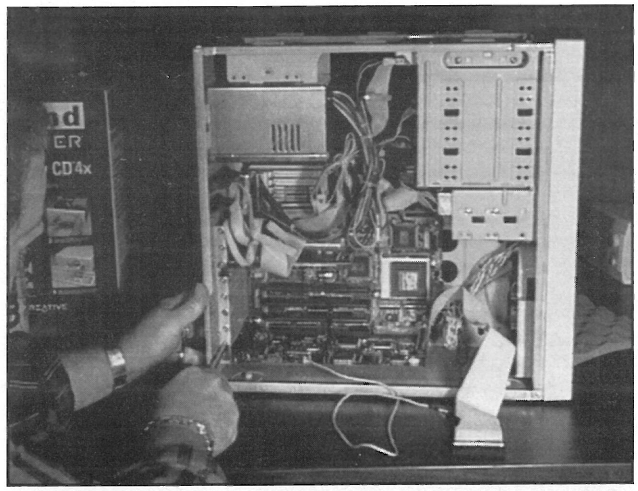
Consider video speed as one of your prerequisites. A rich palette on a card with slow refresh rate isn't going to do much good. Therefore, look for a card that uses video-accelerator chips like the S3 and Tseng 4000 series for best performance on standard-bus motherboards. If the motherboard has a local-bus slot, a local-bus video card is the way to go.

Ultimate in video delivery speed is the PCI bus. Consequently, virtually all of the new Pentium-based motherboards and systems feature PCI slots. Take advantage of the enormous increases in speed available via these slots by purchasing a PCI-based video adapter with at least 1M of DRAM on it (2M or more is even more desirable if your wallet can handle it). Best among PCI boards are those that handle 64-bit video, such as the ATI Mach 64 and STB Velocity 64V, to name just a couple. The next best thing is 32-bit PCI video, which is a bit more affordable.

You also need a video monitor that's capable of fast refresh rates that are



This is the SoundBlaster 16 with both the IDE ribbon interface cable and the audio cable attached. At this point, the card is ready to plug into a 16-bit expansion slot in the PC.



Once the card is firmly and fully seated in the expansion slot, secure its mounting bracket to the PC's backplane with the screw that formerly held the slot blocker in place. In this photo, both the IDE interface and audio cables are already installed on the SoundBlaster 16 card, awaiting attachment to the CD-ROM drive.

commensurate with the capabilities of the video card to obtain the best possible viewing. While a 14" monitor is adequate for 800 × 600 resolution, you'll find it to be taxing on the eyes if you want to use 1,024 × 768 or 1,280 × 1,024 mode. A 15" or, better still, 17" or larger monitor is the way to go for these SVGA resolutions.

A non-interlaced monitor affords the most comfortable viewing without annoying (and eye-tiring) flicker. The few additional dollars for a non-interlaced model is well worth the extra expense.

• **CD-ROM Drives.** A double-spin or multi-spin CD-ROM drive that's capable of delivering a steady, sustained data-transfer rate of at least 250K/s is the slowest drive you should consider, with 300K or faster transfer rates being more desirable. Add to the requirements a built-in data buffer of at least 128K and a maximum seek time of 300 ms to ensure adequate performance for playing multimedia CD-ROM software.

Other desirable features of the CD-ROM drive include CD-ROM XA (extended architecture) and Kodak Photo-CD capability (at least single-session, although multi-session capability is better). While double-speed drives are currently being offered at bargain-basement prices, it makes sense to spend a few more dollars to obtain a quad-speed drive instead. Of course, if you want to be at the current leading-edge of technology, a six-speed drive is the way to go. Prices are coming down rapidly on hex-speed units.

Aside from the foregoing basic specifications, several other options when selecting a CD-ROM drive are largely a matter of personal choice and system and budgetary considerations. Choices include whether to choose a drawer-type drive in which you insert the disc directly or a caddie-type to hold the CD-ROM.

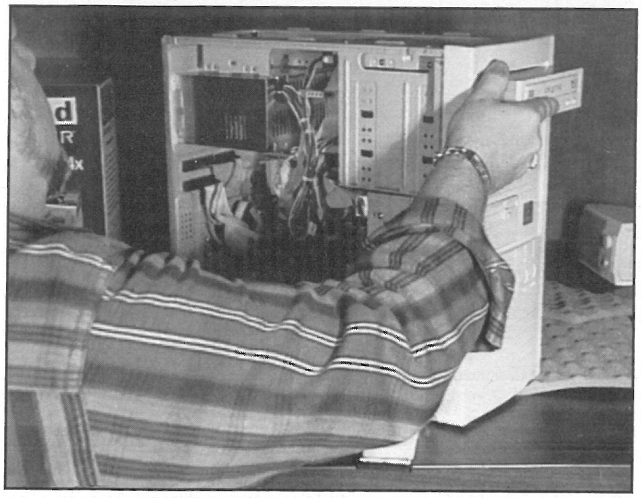
External drives permit easily moving the drive from one machine to another and are easiest to install, although they require a separate ac power source. Internal CD-ROM drives mount in any available 5¼" drive bay that affords front access and draw their power directly from the PC's power supply (they're also generally about $100 less expensive than equivalent external models). Some manufacturers (like Teac) are combining a high-density 3½" floppy drive into the same housing as the CD-ROM drive, giving two drives in a single physical drive bay.

• **CD-ROM Interfaces.** Since an interface is required for the CD-ROM drive to communicate with the host PC, some choices must be made in this area as well. Sony, Hitachi, Philips and Matsushita/Panasonic have their own proprietary interfaces, although each manufacturer also makes SCSI-interfaced models of its drives as well. Generally, there's no great advantage to using a proprietary interface over a SCSI one, except that the manufacturer may have a slightly lower price on its proprietary models.

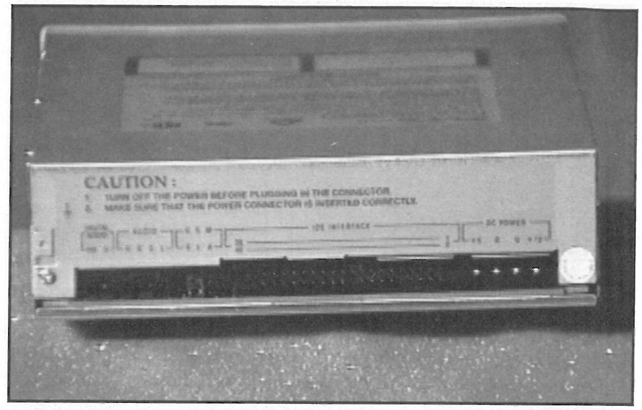
If you already have a sound card, chances are that it has a CD-ROM-drive interface integrated into it. Check this out before shopping for a drive, since you may be able to save some money by purchasing a drive that can use the sound card's interface (provided, of course, you're happy with your current sound card and aren't thinking of upgrading it as well).

A few caveats are in order here, especially if you're thinking of interfacing the CD-ROM drive through the sound card and there are several interface headers provided on it. For example, the Mozart sound card from Oak Technology has Sony, Mitsumi and Panasonic CD-ROM interfaces all integrated into the card. The fact that the Mitsumi and Panasonic interfaces both use 40-pin headers that *look* identical can be confusing and frustrating if you don't realize that these two headers can't be used interchangeably.

While each of the three interface headers are clearly labeled on the Oak card, there still exists a great possibility for making a wrong connection. Though this practice of providing multiple CD-ROM interfaces is fairly common among sound-card makers, all cards aren't as clearly marked as the Mozart, greatly increasing the chances for erroneous connection.



Remove the blocking plate from the desired external-access drive bay and slide the Creative Labs 4× drive into place, pushing it all the way in until its front is flush with the panel.



In this photo of the rear of the Creative Labs 4× CD-ROM drive, the IDE interface pins have orientation numbers. Again, correct orientation of the ribbon cable is essential for the drive to work. To the right of the IDE interface header is the power connector that accepts a "pigtail" connector from the PC's power supply. To the left is the audio connector for routing the drive's audio through the SoundBlaster 16 card.

Another potential area for interfacing problems is orientation of the ribbon cable with internal CD-ROM drive installations. This applies to SCSI, proprietary and IDE drives and interfaces. The side of the ribbon cable that attaches to pin 1 of the drive and the interface card is indicated by a dotted line or solid stripe "tracer" along the edge of the ribbon cable. Some ribbon cables and drives are keyed with notches that prevent incorrect mating of the cable to the drive, but many aren't.

Another potential problem is that many sound cards (and proprietary interface cards) have no keying on their header pins. Hence, it's easy to attach the cable backwards. The header block usually has some marking as to which is pin 1 and which is pin 40 (or pin 50 for SCSI). However, these markings are often difficult to read or are obscured by other components on the card.

Because of the foregoing factors, it's easy to attach the cable to the wrong set of header pins or orient it incorrectly on the correct header. Either error will result in a CD-ROM drive that doesn't function and a frustrated user who requires technical support.

Many manufacturers offer CD-ROM drives that have IDE interfacing, which is the same as your PC's hard drive uses. The advantage of IDE-interfaced CD-ROM drives is that they generally connect via a ribbon cable to the PC's hard-drive controller and, consequently, don't require a separate interface card. This saves an expansion slot. You may find that IDE drives are slightly less expensive than comparable SCSI units from the same manufacturer. So shop around.

• **Sound Cards.** It's truly a beggar's banquet when it comes to selecting a sound card for your multimedia machine. Thanks to their incredible rise in popularity brought about with the advent of *Windows* 3.1, you have your choice of low-end eight-bit cards for about $100 or go all the way to the top of the heap with 16-bit cards that are literally professional sound studios on a circuit board.

As with virtually every other computer peripheral, the more features and capabilities the sound card has, the greater the price. Therefore, consider what you'll be asking of the card before making a purchase decision. For example, if you're interested primarily in playback of production products like games, a mid-range sound card that costs less than $200 should fit the bill. Typically, cards of this caliber provide SoundBlaster compatibility, support recording and utilize an FM-synthesizer chip as the sound-generation source. Other common standard features include a combination MIDI/joystick port and the ability to accept input from a microphone and line-level sources like a CD-ROM drive. Popular cards that fall into this category are the SoundBlaster Pro and Media Vision Pro Audio Spectrum, among others.

If you're interested in higher-quality stereophonic sound, consider a card that utilizes a wavetable sound generator and incorporates a DSP (digital signal processor). Principal advantages of cards using these components are much better sound quality and a wider range of special effects.

Wavetable sound uses digital samples of actual instrument sounds, as opposed to FM (frequency modulated) synthesis that generates facsimiles of musical-instrument sounds.

FM-based cards are limited by their FM chips regarding the number and complexity of sounds they can generate. Since the sounds of wavetable cards are software-based, you can download new and additional sound "patches" to the card at any time.

Wavetable cards also usually provide an option for adding memory to increase on-board voicing capabilities. Digital signal processing, also an inherent design feature of wavetable-based cards, makes it possible to add such special effects as reverberation, echo, flanging, cross-channel panning, etc. to give the sounds and music more realism and spatial acuity. These cards also usually have an FM-synthesizer chip or the ability to emulate one to ensure compatibility with software designed for FM-based cards.

Wavetable cards typically sell for $300 and more. If you're serious

(Continued on page 107)

By Fred Eady

Getting to Know the MMT-188EB SBC

This powerful SBC offers easy implementation of sophisticated process/control projects

If you've read any of my previous *MicroComputer Journal* articles, you know I'm a "let's build it" kind of guy. Most of the, time this is a great idea, unless you're pressed for time and your project needs a minimal-effort hardware/software solution. This is when "let's build one" translates to "buy one." Believe it or not, buying one isn't a bad idea in some cases.

In this article, I'll walk you through the basic functions of a very powerful 80C188EB-based microprocessor board from Midwest Micro-Tek called the MMT-188EB. By the time you finish reading this article, dozens of ideas will be chasing each other in your head on how to put this handy unit to good use.

```
>
            MENU 1 - *** MMT-188 80188/EB Monitor
A -                             - enter ASCII into RAM - term w/ Ctl-C
D - D(Seg:)start add(,end add)  - Display memory
E - E(Seg:)start add            - Enter/subst RAM - space bar advances address
                                - terminate with return key
F - F(Seg:)start add,end add,data - Fill RAM with constant
G - G(Seg:)hhhh(,Bpt Add)       - Go to address w/ optional breakpoint
H - H                           - Load Intel Hex file
I - Iport add                   - Input from port
L - L(Seg:)(start add)(,end add) - Dis-Assemble Instructions
M - M(Seg:)start add,end add,(Seg:)destination - Move memory
O - Oport add,data              - Output to port
R - R                           - display Registers
T - T                           - Trace instruction at current IP (ROM or RAM)
V - V(Seg:)start add,end add,(Seg:)dest add - Verify 2 blocks of memory
W - W(Seg:)start add,end add    - Write Intel hex file
X - Xregister name              - enter new register value
Y - Ynumb1,numb2                - Hex math - Sum & Difference
2 -                             - switch to MENU 2 cmds
? -                             - Display Menu

  *** (Seg:) = Optional Segment Address ** add = 1 to 4 bytes of address ***
>
 ALT-F10 HELP | ANSI-BBS | FDX | 9600 N81 | LOG CLOSED | PRT OFF | CR | CR
```

Fig. 1. Screen capture of the MMT-188EB Menu 1 screen.

MMT-188EB Description

The MMT-188EB single-board computer (SBC) is based on the INTEL 80188 high-integration eight-bit microprocessor. The 80188 core CPU is actually an enhanced 8088-2. Thus, if you can write code for your PC, you can write code for the MMT-188EB. You can use C, C++, Pascal or native assembler, as long as your compiler generates 80188-compatible code.

The MMT-188EB runs at 16 MHz and can address up to 1M of memory. Two serial ports are standard, as is a 24-bit 82C55-based parallel I/O subsystem. There are also a couple of timer/counters, two hardware interrupt lines, a Watchdog timer and a power-failure detector.

Options for the MMT-188EB include an eight-bit analog-to-digital (A/D) converter, Dallas Semiconductor SmartSocket Real Time Clock Module, RS-422/485 communication port and a monitor/ debugger EPROM coupled with 8K X 8 of static RAM.

Access to the MMT-188EB peripherals is provided through a 50-pin and a 60-pin header. The serial ports are interfaced to the real world by two 10-pin headers. The beauty of this microprocessor board is that you need not be concerned with the minuscule

```
 - D(Seg:)start add(,end add)  - Display memory
 - E(Seg:)start add            - Enter/subst RAM - space bar advances address
                               - terminate with return key
 - F(Seg:)start add,end add,data - Fill RAM with constant
 - G(Seg:)hhhh(,Bpt Add)       - Go to address w/ optional breakpoint
 - H                           - Load Intel Hex file
 - Iport add                   - Input from port
 - L(Seg:)(start add)(,end add) - Dis-Assemble Instructions
 - M(Seg:)start add,end add,(Seg:)destination - Move memory
 - Oport add,data              - Output to port
 - R                           - display Registers
 - T                           - Trace instruction at current IP (ROM or RAM)
 - V(Seg:)start add,end add,(Seg:)dest add - Verify 2 blocks of memory
 - W(Seg:)start add,end add    - Write Intel hex file
 - Xregister name              - enter new register value
 - Ynumb1,numb2                - Hex math - Sum & Difference
 -                             - switch to MENU 2 cmds
 -                             - Display Menu

 *** (Seg:) = Optional Segment Address ** add = 1 to 4 bytes of address ***
R
X=1122 BX=0000 CX=FFFF DX=0040 SP=0780 BP=0000 SI=FFFF
I=0000 CS=FC00 DS=0000 SS=0000 ES=0000 IP=2152 FL=F002

ALT-F10 HELP | ANSI-BBS | FDX | 9600 N81 | LOG CLOSED | PRT OFF | CR | CR
```

Fig. 2. Results of executing the R command.

hardware details, and all of this power requires only a 5-volt at 500-mA to 1-ampere dc power supply!

The MMT-188EB is equipped with the Monitor/Debugger EPROM and SRAM module that lets you exercise the MMT-188EB right out of the box. It's also an excellent way to describe the basic functionality of the MMT-188EB SBC.

The MMT-188EB is quite capable. To exploit the SBC to its fullest, Paradigm Corp. markets a two-pronged enhanced software-development package for the MMT-188EB that consists of two powerful applications: Paradigm Debug and Paradigm Locate. I'll discuss the Paradigm products in the next issue. For now, let's take a closer look at the MMT-188EB Monitor/Debugger.

Monitor/Debugger

Most serious embedded projects that require the services of an SBC like the MMT-188EB end up as an EPROM-based application that dedicates the SBC to a particular task. If this is where you're headed, fine. But one must crawl before walking, and this is where this article and the MMT-188EB Monitor/Debugger come into play.

With the addition of a nine-pin serial cable connected to a dumb terminal or a PC running a terminal emulator and 5 volts dc, the MMT-188EB comes to life. No null-modem arrangements, special power supplies, proprietary software are needed. The MMT-188EB is about as hassle-free as an SBC can get.

With the hard work already done for you, you can concentrate on developing a solution to effectively implement your application. At this point, you don't even need an assembler!

A screen capture of the MMT-188-EB Menu 1 screen is shown in Fig. 1. You can perform a number of serious operations from this screen by simply entering commands. Menu 2 consists of the A/D command and various utilities that permit continuous port operations and testing. I won't discuss Menu 2 in this offering, but let's analyze some of the Menu 1 commands in a logical order.

I start with R, the display-registers command. This command displays the contents of the general-purpose

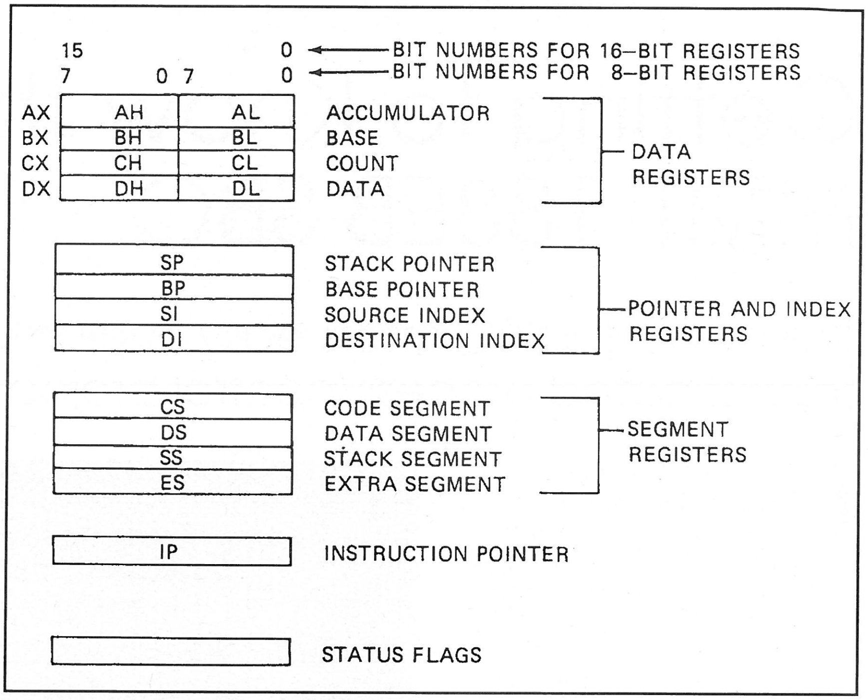


Fig. 3. Layout of the 80188 general-purpose registers.

register stack of the 80188. The results of executing the R command are illustrated in Fig. 2.

AX, BX, CX and DX are general-purpose data registers. The MMT-188EB's data registers are unique in that their upper and lower halves are separately addressable. Each register can be used as a 16-bit register or two eight-bit registers. The 'X' in the register name denotes 16-bit mode.

For eight-bit operations, the registers are divided into high and low bytes. For instance, BH is the high byte of BX, while BL denotes the low byte of BX. These general-purpose registers are usually used in standard arithmetic and logic operations.

The SP and BP registers both operate on the stack. The stack is simply a user-defined and -allocated linear array found in real memory that's used to store subroutine parameters or data that may have to be temporarily saved during execution of a program.

Stack pointer SP points to the base

```
>XDS=FC00->C000
>R
AX=1122 BX=0000 CX=FFFF DX=0040 SP=0780 BP=0000 SI=FFFF
DI=0000 CS=C000 DS=C000 SS=0000 ES=0000 IP=2152 FL=F002
>DC000:0001,0002
C000:0001 FD 3B    .;
>DC000:0000
C000:0000 E9 FD 3B EB 73 90 EB 38 90 EB 39 90 EB 3A 90 EB   ..;.s..8..9..:..
C000:0010 3B 90 EB 3C 90 EB 3D 90 EB 3E 90 EB 3F 90 EB 40   ;..<..=..>..?..@
C000:0020 90 EB 41 90 EB 42 90 EB 43 90 EB 44 90 EB 45 90   ..A..B..C..D..E.
C000:0030 E9 CD 3B E9 CA 3B E9 C7 3B E9 C4 3B FF 00 00 00   ..;..;..;..;....
C000:0040 E8 A0 1F CB E8 AE 1F CB E8 B9 1F CB E8 D5 1F CB   ................
C000:0050 E8 BF 1F CB E8 BF 1F CB E8 6A 1C CB E8 67 1C CB   ..........j...g..
C000:0060 E8 64 1C CB E8 61 1C CB E8 5E 1C CB E8 5B 1C CB   .d...a...^...[..
C000:0070 E8 58 1C CB E8 55 1C CB B8 00 00 8E D0 8E D8 B0   .X...U..........
C000:0080 31 EB 78 B8 00 00 8E D8 E8 63 1D B0 3E E8 74 1F   1.x.......c..>.t.
C000:0090 C6 06 A2 06 00 C6 06 A3 06 00 32 C0 A2 6C 06 E8   ..........2..l..
C000:00A0 40 00 3C 3F 74 43 3C 1B 74 3F 3C 05 75 03 E9 F0   @.<?tC<.t?<.u...
C000:00B0 00 3C 31 74 46 3C 32 74 6C E8 48 1F 3C 41 72 C3   .<1tF<2tl.H.<Ar.
C000:00C0 3C 5A 7F BF B4 00 2C 41 D0 E0 80 3E 00 06 31 74   <Z....,A...>..1t
C000:00D0 05 05 6B 01 EB 03 05 37 01 8B D8 2E 8B 07 FF D0   ..k....7........
C000:00E0 EB A1 E8 10 1F E8 F0 1E C3 A0 00 06 3C 31 BE F2   ............<1..
C000:00F0 21 74 03 BE F2 26 E8 12 1D EB 88 A2 00 06 B8 37   !t...&.........7
>
ALT-F10  HELP | ANSI-BBS | FDX |  9600 N81 | LOG CLOSED | PRT OFF | CR | CR
```

Fig. 4. Correct syntax to alter the DS register to point to the C000 area of memory.

address of the physical stack, while BP is known as the base pointer. BP is used to index into the stack and generally points to something other than the actual subroutine return address. If your program doesn't require a stack (no subroutines or interrupts), SP and BP can also be used as general-purpose registers.

SI and DI are the index registers you use to manipulate data structures and are capable of automatic-increment and automatic-decrement operations. These registers have general arithmetic and logical capabilities, in addition to their special functionality.

CS, DS, SS and ES are segment registers. CS delineates the code segment, DS marks the data segment, SS points to the stack segment and ES is called the extra segment. These register values are normally set by you to group portions of memory into logical areas. For instance, the code segment usually contains the actual program code, while the stack segment contains the stack array you implemented. DS and ES are normally implemented as pointers to data areas.

Each segment is a linear memory area up to 64K in size. Bytes within a segment are stored sequentially, starting at 00000h and ending at FFFFFh. In the 80188, memory is addressed using a two-component address consisting of a pointer, which is the 16-bit segment address, and a 16-bit offset, which is the address within the segment. A 20-bit physical memory address is calculated by shifting the base value (segment register value) four bits to the left and adding the 16-bit offset. This results in the capability of addressing 1M of memory.

Assume the DS register, loaded with C000h, is pointing to a data area in our program and you need to access the byte at location 1, which is the second byte, within the data segment. Using the memory-addressing rules for the 80188, here's how to calculate the physical address of our data byte:

C0000	C000 shifted four bits to left
0001	0001 is second byte within DS segment
C0001	Resulting 20-bit address

The two remaining registers displayed by the R command are the IP instruction pointer and the FL or flags register. IP is simply the program counter, and FL contains bits that correspond to such conditions as overflow and carry. You'll find these types of registers in almost all micros, and there's nothing fancy or special about these particular 80188 registers. Layout of the 80188 general-purpose registers is shown in Fig. 3.

```
? -                              - Display Menu

  *** (Seg:) = Optional Segment Address ** add = 1 to 4 bytes of address ***
>A1500:0000
MicroComputer Journal♥
@0015
>D1500:0000
1500:0000 4D 69 63 72 6F 43 6F 6D 70 75 74 65 72 20 4A 6F   MicroComputer Jo
1500:0010 75 72 6E 61 6C FF FF FF FF FF FF FF FF FF FF FF   urnal...........
1500:0020 FF 00 00 FF FF 00 00 FF FF 00 00 FF FF 00 00 FF   ................
1500:0030 F7 00 00 FF FF 00 00 7D FE 00 00 FF EF 00 00 FF   ................
1500:0040 FF 00 00 FF FF 00 00 FF FD 00 00 FF FF 01 00 FF   ................
1500:0050 FF 00 00 FF FF 00 00 FD FF 00 00 FF FF 00 00 7F   ................
1500:0060 FF 00 00 FF FF 00 00 FF FF 04 00 FF F7 00 00 FF   ................
1500:0070 FF 00 00 FF 7F 10 00 FF FF 80 00 FD FF 00 10 FF   ................
1500:0080 FF 00 00 FF FF 00 08 FF FF 01 00 FF FF 00 00 FF   ................
1500:0090 EF 40 00 FD FF 00 00 FF FF 00 00 FF FF 42 00 FF   .@...........B..
1500:00A0 FF 00 00 FF FF 00 00 FF FF 02 00 BF FF 00 00 FF   ................
1500:00B0 FF 00 00 FF FF 00 00 FF FF 00 00 FF FF 08 00 FF   ................
1500:00C0 FF 02 00 FF FF 00 00 FF FF 00 00 FF FF 00 00 FF   ................
1500:00D0 FF 00 00 FE FF 00 00 FF FF 00 00 FF FF 00 00 FF   ................
1500:00E0 FF 00 00 FF FF 00 00 FF FF 00 00 FF FF 00 00 FF   ................
1500:00F0 FF 00 00 FF FF 00 00 FF FF 00 00 FF FF 00 00 FF   ................
>
 ALT-F10  HELP | ANSI-BBS | FDX | 9600 N81 | LOG CLOSED | PRT OFF | CR | CR
```

Fig. 5. Use A command to enter some text into RAM at location 1500:0000 and then display it using other MMT-188EB Monitor/Debugger commands.

You just computed a physical address in the DS segment, but how do you look at the data at this address using our MMT-188EB Monitor/ Debugger? You use the X register modify and D display memory commands. The correct syntax to alter the DS register to point to the C000 area of memory, >XDS=FC00->C000, is shown in Fig. 4.

I had you follow the X command with an R command to show the results of the X command execution. DS now contains the value C000h and is pointing to that location in real storage. The next D command (>DC000:-0001,0002) in Fig. 4 is a screen dump that shows the results of executing the D command to display segment DS (C000h) memory location 1.

Note the way the 20-bit physical address is represented. The MMT-188EB Monitor/Debugger program always displays the 20-bit address as the segment value separated by a colon from the offset value. Thus, your desired DS physical location would be displayed as C000:0001. The final command, >DC000:0000, in Fig. 4 shows a dump of the first 256 bytes in segment C000. Note that the offset value ranges from 0000 to 00F0, or 256 bytes.

To reinforce the segment concept,

```
? -                              - Display Menu

  *** (Seg:) = Optional Segment Address ** add = 1 to 4 bytes of address ***
>E1500:0000
1500:0000 FF-BA  FF-43  FF-00  FF-B0  FF-80  FF-EE  FF-BA  FF-40
1500:0008 FF-00  FF-B0  FF-55  FF-EE
>D1500:0000
1500:0000 BA 43 00 B0 80 EE BA 40 00 B0 55 EE FF FF FF FF   .C.....@..U.....
1500:0010 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF   ................
1500:0020 FF 00 00 FF FF 00 00 FF FF 00 00 FF FF 00 00 FF   ................
1500:0030 F7 00 00 FF FF 00 00 7D FE 00 00 FF EF 00 00 FF   ................
1500:0040 FF 00 00 FF FF 00 00 FF FD 00 00 FF FF 01 00 FF   ................
1500:0050 FF 00 00 FF FF 00 00 FD FF 00 00 FF FF 00 00 7F   ................
1500:0060 FF 00 00 FF FF 00 00 FF FF 04 00 FF F7 00 00 FF   ................
1500:0070 FF 00 00 FF 7F 10 00 FF FF 80 00 FD FF 00 10 FF   ................
1500:0080 FF 00 00 FF FF 00 08 FF FF 01 00 FF FF 00 00 FF   ................
1500:0090 EF 40 00 FD FF 00 00 FF FF 00 00 FF FF 42 00 FF   .@...........B..
1500:00A0 FF 00 00 FF FF 00 00 FF FF 02 00 BF FF 00 00 FF   ................
1500:00B0 FF 00 00 FF FF 00 00 FF FF 00 00 FF FF 08 00 FF   ................
1500:00C0 FF 02 00 FF FF 00 00 FF FF 00 00 FF FF 00 00 FF   ................
1500:00D0 FF 00 00 FE FF 00 00 FF FF 00 00 FF FF 00 00 FF   ................
1500:00E0 FF 00 00 FF FF 00 00 FF FF 00 00 FF FF 00 00 FF   ................
1500:00F0 FF 00 00 FF FF 00 00 FF FF 00 00 FF FF 00 00 FF   ................
>
 ALT-F10  HELP | ANSI-BBS | FDX | 9600 N81 | LOG CLOSED | PRT OFF | CR | CR
```

Fig. 6. Enter object code beginning at memory location 1500:0000 into MMT-188EB using E command.

use the A command to enter some text into RAM at location 1500:0000 and then display it using other MMT-188-EB Monitor/Debugger commands. Figure 5 shows how easy this is to do. This command is useful when you're putting together ASCII messages your program will either respond to or respond with.

What you just did with text and the A command you can also do with actual program code. You can use the E command to enter a tiny program one byte at a time, the D command to display the code you entered, the X command to point to the beginning of your program and the T command to execute it one instruction at a time. With this in mind, let's put together a simple example program that writes a value to the MMT-188EB parallel port. Before moving on to the code, let's examine the MMT-188EB's parallel I/O subsystem.

Parallel I/O Subsystem

As I stated above, the MMT-188EB uses the Intel 82C55 PPI to effect a 24-bit I/O subsystem. The 82C55 is my favorite because it incorporates three eight-bit I/O ports that are programmable and fully TTL-compatible. The 24 I/O pins can be individually programmed in two groups of 12 and used in three major modes of operation.

The number 12 infers that Port C can be divided into two individual four-bit ports that are used in conjunction with eight-bit Ports A and B. Port A and Port C Upper (C4 through C7) make up one group, while Port B and Port C Lower (C0 through C3) comprise the other group. Modes of operation are selected by writing specific bit patterns (a Control Word) to the Control Register. The following is a brief description of the three major modes:

Mode 0 defines 16 combinations of two eight-bit ports and two four-bit ports. Outputs are latched while inputs aren't latched, and any port can be input or output.

Mode 1 uses strobes or "handshaking" signals to transfer data to and from the I/O device. Lines on Port C generate and accept the "handshaking" signals. Mode 1 defines two groups, A and B, with each group containing an eight-bit data port and a one-bit control or data port. Both eight-bit ports can be either input or output, with inputs and outputs being latched.

Mode 2 provides for communicating on a single eight-bit bus with handshaking signals similar to Mode 1. Mode 2 is defined as one eight-bit bidirectional bus port (Port A) with a five-bit control port (Port C). Mode 2 is a Group A-only mode, with both inputs and outputs being latched.

Under normal circumstances, you'd refer to the *Intel Peripheral Components Product Manual* to select a mode suitable for your application. To eliminate complexity, I'll use Mode 0 in this example.

The MMT-188EB comes with very good documentation. Referring to Chapter Three in the *Programming Reference*, you find the MMT-188-EB-implemented port memory addresses of the 82C55 to be as follows:

```
? -                             - Display Menu

  *** (Seg:) = Optional Segment Address ** add = 1 to 4 bytes of address ***
>XCS=FC00->1500
>XIP=0900->0000
>T1500:0000  BA MOV DX,0043
AX=1122 BX=0000 CX=FFFF DX=0043 SP=0780 BP=0000 SI=FFFF
DI=0000 CS=1500 DS=C000 SS=0000 ES=0000 IP=0003 FL=F002
>T1500:0003  B0 MOV AL,80
AX=1180 BX=0000 CX=FFFF DX=0043 SP=0780 BP=0000 SI=FFFF
DI=0000 CS=1500 DS=C000 SS=0000 ES=0000 IP=0005 FL=F002
>T1500:0005  EE OUT DX,AL
AX=1180 BX=0000 CX=FFFF DX=0043 SP=0780 BP=0000 SI=FFFF
DI=0000 CS=1500 DS=C000 SS=0000 ES=0000 IP=0006 FL=F002
>T1500:0006  BA MOV DX,0040
AX=1180 BX=0000 CX=FFFF DX=0040 SP=0780 BP=0000 SI=FFFF
DI=0000 CS=1500 DS=C000 SS=0000 ES=0000 IP=0009 FL=F002
>T1500:0009  B0 MOV AL,55
AX=1155 BX=0000 CX=FFFF DX=0040 SP=0780 BP=0000 SI=FFFF
DI=0000 CS=1500 DS=C000 SS=0000 ES=0000 IP=000B FL=F002
>T1500:000B  EE OUT DX,AL
AX=1155 BX=0000 CX=FFFF DX=0040 SP=0780 BP=0000 SI=FFFF
DI=0000 CS=1500 DS=C000 SS=0000 ES=0000 IP=000C FL=F002
>
ALT-F10 HELP | ANSI-BBS | FDX | 9600 N81 | LOG CLOSED | PRT OFF | CR | CR
```

Fig. 7. This screen spells out details for executing your sample code.

```
M - M(Seg:)start add,end add,(Seg:)destination - Move memory
O - Oport add,data                - Output to port
R - R                             - display Registers
T - T                             - Trace instruction at current IP (ROM or RAM)
V - V(Seg:)start add,end add,(Seg:)dest add - Verify 2 blocks of memory
W - W(Seg:)start add,end add      - Write Intel hex file
X - Xregister name                - enter new register value
Y - Ynumb1,numb2                  - Hex math - Sum & Difference
2 -                               - switch to MENU 2 cmds
? -                               - Display Menu

  *** (Seg:) = Optional Segment Address ** add = 1 to 4 bytes of address ***
>D1500:0000 000F
1500:0000 BA 43 00 B0 80 EE BA 40 00 B0 55 EE FF FF FF FF   .C.....@..U.....
>L1500:0000 000F
1500:0000 BA MOV DX,0043
1500:0003 B0 MOV AL,80
1500:0005 EE OUT DX,AL
1500:0006 BA MOV DX,0040
1500:0009 B0 MOV AL,55
1500:000B EE OUT DX,AL
1500:000C FF  FF - Undefined OPCOD or Modifier !!

>
ALT-F10 HELP | ANSI-BBS | FDX | 9600 N81 | LOG CLOSED | PRT OFF | CR | CR
```

Fig. 8. Details for disasselbling monitor command.

Listing 1. Author's Code Snippet

Object CodeE	Source Code		Remarks
BA 0043	mov	dx,0043h	;point to control register
B0 80	mov	al,80h	;Mode 0..Ports A,B,C outputs
EE	out	dx,al	;write control word
BA 0040	mov	dx,0040h	;point to Port A
B0 55	mov	al,55h	;load accumulator with 55h
EE	out	dx,al	;write 55h to Port A

Address	I/O Device
40H	82C55A Port A
41H	82C55A Port B
42H	82C55A Port C
43H	82C55A Control Register

Now that you know where to address your efforts, writing and executing the code snippet is simple. Essentially, all you have to do is initialize the 82C55 by writing a control word to address 43h and write your data to one of the 82C55A ports. The following example initializes the MMT-188-EB 82C55 to Mode 0 with all ports as outputs and then writes 55h to Port A.

If you're an assembler connoisseur, you'll note the absence of all of the supporting code required to compile the code using an assembler/linker program. It isn't needed here because you'll hand-assemble and input the object code via the Monitor/ Debugger. The hand-assembled source-code snippet is given in Listing 1. To find out how you did this, look it up in the Intel *80C186EB/80C188EB User's Manual*. Now let's "assemble" mov dx,0043h.

In this example, the mov instruction is used to move an immediate 16-bit operand, 0043h, to the DX register. The syntax is:

1011 w reg I data high I data low

In this case, w is equal to 1 for 16 bits and reg equates to 010 for DX. Data-high is 00, and data-low is 43h. The source (SRC) is the data, and the destination (DEST)is the register DX. Put this all together, and you get: 10111010 00000000 01000011 or BA 00 43. That's all there is to it. You can use this same method on the rest of the instructions in the code snippet.

Now enter the object code beginning at memory location 1500:0000 into your MMT-188EB using the E command, as shown in Fig. 6. Note that in the resultant dump of your code, 0043h was entered as 4300h following the BA opcode. This is standard Intel "backwards" format.

You've written a small program, hand-assembled it and entered it into memory. Only one thing is left to do: execute it. To do this, you must first use the X command to set your CS (code segment) register to 1500h and the IP (instruction pointer) to 0000, the offset and beginning of your program. As you learned above, this is represented as address 1500:0000. It takes only six T commands to write 55h out to Port A. This entire operation is illustrated in Fig. 7.

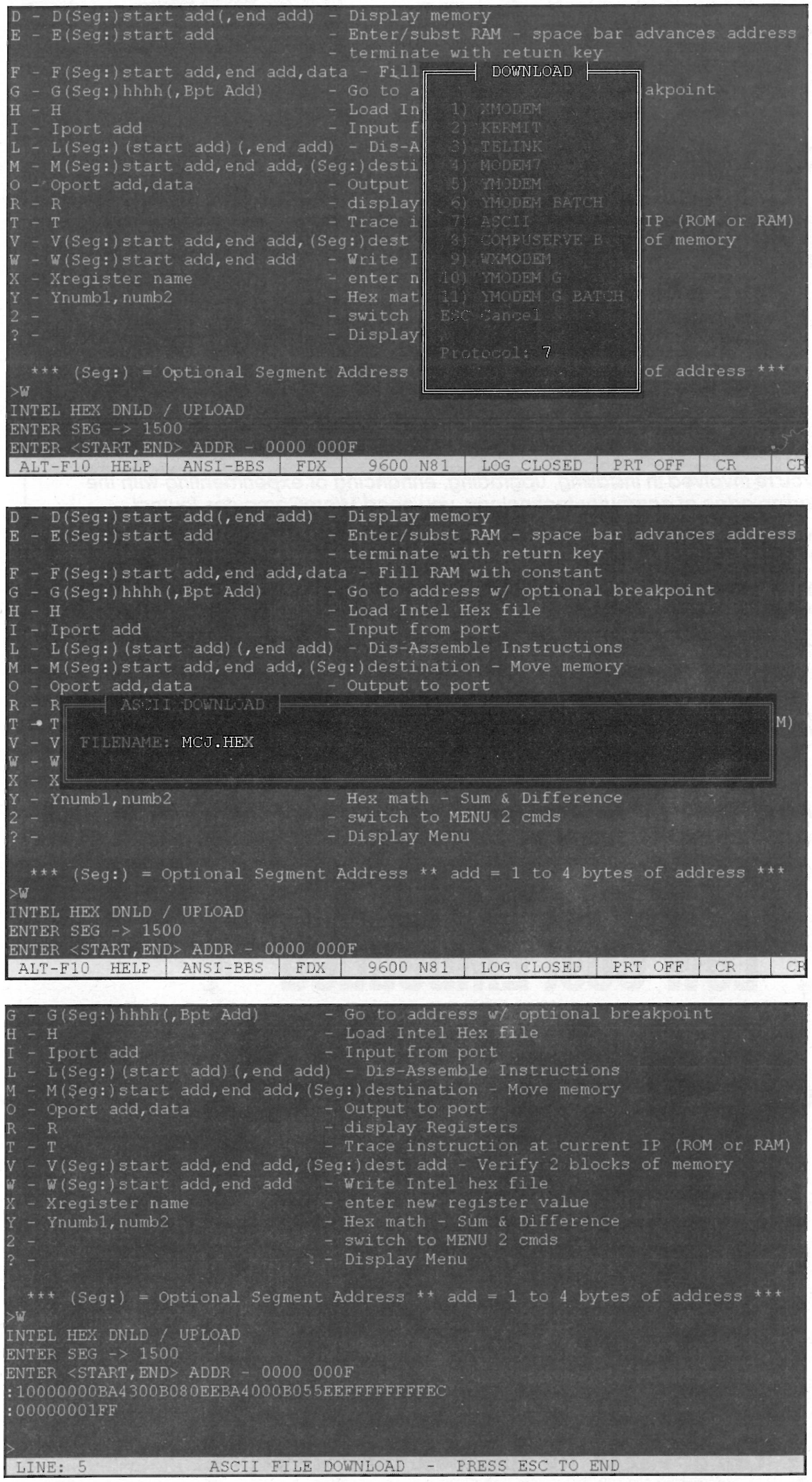


Fig. 9. These three screens detail procedure to use to save your working code so that you can reload and use it later. To get file back into MMT-188EB, simply Load Intel Hex File command H.

The T, or Trace, command is a neat way to single-step your program and follow along with the results of op-code execution. All of the general-

Table 1. OPTO22 Interface Pinouts

Pin	Signal	Description
1	8255A-A PortA Bit 0	I/O
3	8255A-A PortABit 1	I/O
5	8255A-A PortA Bit 2	I/O
7	8255A-A PortA Bit 3	I/O
9	8255A-A PortA Bit 4	I/O
11	8255A-A PortA Bit 5	I/O
13	8255A-A PortA Bit 6	I/O
15	8255A-A PortA Bit 7	I/O
17	8255A-A PortB Bit 0	I/O
19	8255A-A PortB Bit 1	I/O
21	8255A-A PortB Bit 2	I/O
23	8255A-A PortB Bit 3	I/O
25	8255A-A PortB Bit 4	I/O
27	8255A-A PortB Bit 5	I/O
29	8255A-A PortB Bit 6	I/O
31	8255A-A PortB Bit 7	I/O
33	8255A-A PortC Bit 0	I/O
35	8255A-A PortC Bit 1	I/O
37	8255A-A PortC Bit 2	I/O
39	8255A-A PortC Bit 3	I/O
41	8255A-A PortC Bit 4	I/O
43	8255A-A PortC Bit 5	I/O
45	8255A-A PortC Bit 6	I/O
47	8255A-A PortC Bit 7	I/O
49	V_{cc}	+5 Volts
Even Nos.	GND	Ground

Table 2. MT-88EB Addresses

Port/Memory Addresses	I/O Device or Memory Block
000h	74LS244 Chip Select
040h	82C55A Port A
041h	82C55A Port B
042h	82C55A Port C
043h	84C55A Control Register
080h	IO USER0
0C0h	IO USER1
100h	IO USER2
140h	A/D Converter, MAX150
00000h	Memory Socker U4
80000h	Memory Socket U3

Table 3. Port Pinouts

RS-232

10-Pin Stake		DB-9 Connector	
Pin	Signal	Pin	Signal
1	No Connection	1	No Connection
2	DTR (DSR)	2	DTR (DSR)
3	TxD Input	3	TxD Input
4	CTS Input	4	CTS Input
5	RxD Output	5	RxD Output
6	RTS Input	6	DSR (DTR)
7	DSR (DTR)	7	No Connection
8	No Connection	8	GND
9	GND	9	
10	No Connection		

RS-422/485

Pin	Signal	Pin	Signal
1	DIF+	1	DIF+
8	DIF-	9	DIF-
9	GND	5	GND
2,3,4,5,6,10	N.C.	2,3,4,6,7,8	N.C.

purpose registers are updated with each T command. You can also interrogate memory or change register or memory values between T commands.

After a while, you begin to learn some or most of the opcodes by sight. However, in the beginning, they're all just hex. Figure 8 demonstrates the disassemble monitor command. Does this program look familiar? Is this great or what!?

Having come this far, you'll want to save your working code so that you can reload and use it later. The MMT-188EB Monitor/Debugger has this covered, too, using the W, or Write

Where to Buy
MMT-1887 EB SBC, $239 **Midwest Micro-Tek** 2308 E. Sixth St. Brookings, SD 57006 Tel.: 605-697-8521; fax: 605-692-5112 CIRCLE NO. 155 ON FREE INFORMATION CARD *C/C++ Power Pack*, $995 **Paradigm Systems** 3301 Country Club Rd., Ste. 2214 Endwell, NY 13760 Tel.: 1-800-537-5043 CIRCLE NO. 156 ON FREE INFORMATION CARD

Table 4. 60-Pin Expansion Header Pinouts

Pin	I/O Signal	Pin	I/O Signal
1	Ground (GND)	2	+5 Volts (V_{cc})
3	Hold Acknowledge (HLDA)	4	CPU Ready Line (READY#)
5	CPU Hold (HOLD))	6	I/O User Select 1 (IO_USER1#0
7	I/O User Chip Select 0 (IO_USER0#)	8	I/O User Select 2 (IO_USER2#)
9	Offboard Memory Chip Select (OBMCS#)	10	CPU Clock Signal (CLK)
11	Data Line 00	12	Address Line 00
13	Data Line 01	14	Address Line 01
15	Data Line 02	16	Address Line 02
17	Data Line 03	18	Address Line 03
19	Data Line 04	20	Address Line 04
21	Data Line 05	22	Address Line 05
23	Data Line 06	24	Address Line 06
25	Data Line 07	26	Address Line 07
27	Data Line 08	28	Address Line 08
29	Data Line 09	30	Address Line 09
31	Data Line 10	32	Address Line 10
33	Data Line 11	34	Address Line 11
35	Data Line 12	36	Address Line 12
37	Data Line 13	38	Address Line 13
39	Data Line 14	40	Address Line 14
41	Data Line 15	42	Address Line 15
43	Read Line (RD#)	44	Address Line 16
45	Write Line (WR#)	46	Address Line 17
47	Hardware Interrupt 1 (INT2)	48	Address Line 18
49	Battery Input (VBAT)	50	Address Line 19
51	+5 Volts (V_{cc})	52	Ground (GND)
53	Timer 0 Input (T0IN)	54	Hardware Interrupt 0 (INT0)
55	Timer 1 Input (T1IN)	56	Reset Output (RESET)
57	Timer 0 Output (T0OUT)	58	No Connection
59	Timer 1 Output (T1OUT)	60	Non-Maskable Interrupt (NMI)

Intel Hex File, command. The three screen captures in Fig. 9 demonstrate the technique. Of course, to get the file back into the MMT-188EB, you'd simply employ the H, Load Intel Hex File, command.

In Closing

As you can see, the MMT-188EB is a very-powerful yet easy-to-use SBC. Think about the possibilities. You could prototype an entire project without ever having to use an assembler or building a prototype. You could write and test code in small easy-to-debug pieces. You can exercise parallel and A/D I/O without writing a single byte of code.

No special tools or test equipment are required to use the MMT-188EB.

I've included here in Fig. 10 a layout diagram for the MMT-188EB

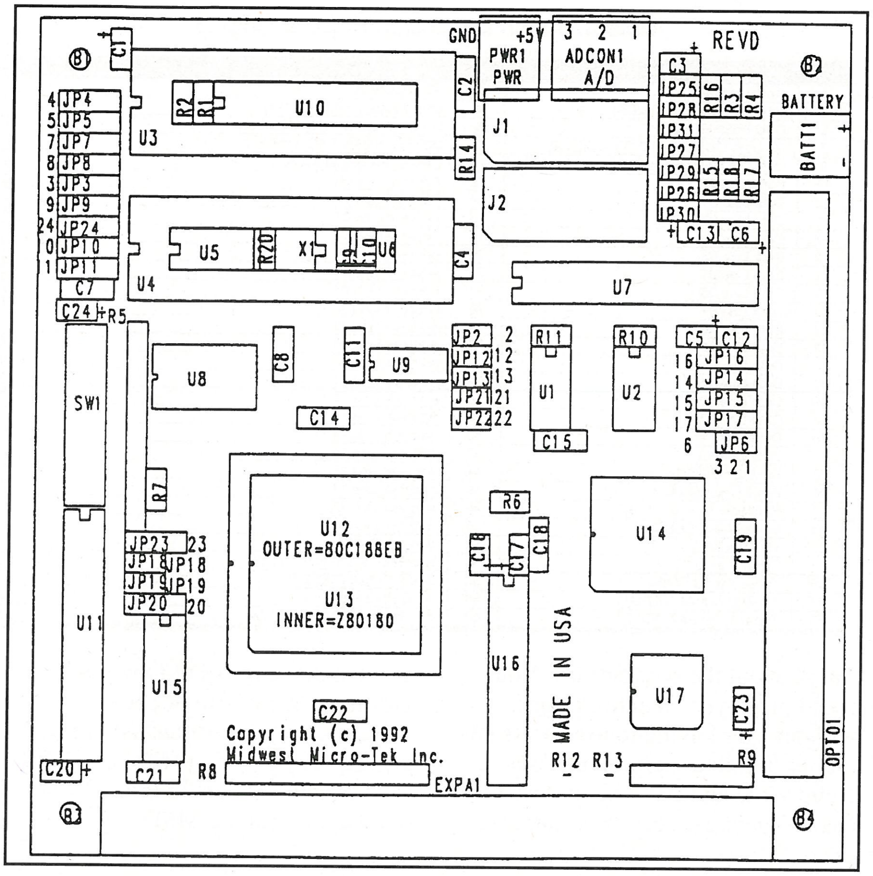
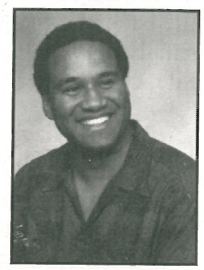


Fig. 10. Physical layout details of MMT-188EB board.

board and Tables 1 through 4 that describe the layout of the physical connectors and the logic behind the memory-map scheme. If you decide to get one of these fantastic boards before the next installment, you'll be pleasantly surprised to find that the documentation includes a diskette that contains examples of code you can apply directly to your 80188 applications. Not only does the MMT-188EB documentation shine, the technical support I received was excellent.

For those of you who were born to write code, grease up you hex calculators because next time, I'll introduce the Paradigm Debug and Paradigm Locate applications and show you how to use the serial I/O and A/D features of the MMT-188EB. ■



Fred Eady

By TJ Byers

Windows 95: Upgrade Now Or Later?

Windows 95 is here to stay, but does it have to be your future just yet?

With all the fanfare of a Barnum & Bailey circus arriving in town, Microsoft proudly announced *Windows 95*—the long-awaited *Windows* operating system that's supposed to take us into the Twenty-First Century. But is *Windows 95* for you?

Unlike *Windows* 3.1 and *Windows for Workgroups* 3.11, *Windows 95* is *not* a DOS overlay. That is, you don't have to install DOS first as a base platform and then add *Windows* on top of it. Instead, *Windows 95* is a stand-alone operating system, as is Unix, that's compatible with existing DOS and *Windows* software. Consequently, it doesn't look or behave like either DOS or *Windows* 3.1.

When contemplating making a choice of *Windows 95* as opposed to other operating systems, you need to ask yourself a few pertinent questions. Among these are: Why should you upgrade to *Windows 95*, and what will you gain by doing so? How difficult is the upgrade? Will your PC handle the new operating system, or will it buckle under its demands? Can you run your existing applications, or will you have to buy new software as well? How difficult is *Windows 95* to learn and use?

In this article, I don't tout the merits of *Windows 95,* nor do I dwell on its shortcomings. Instead, my objective here is to provide you an overview of what to expect if you decide to upgrade to *Windows 95* and let you make your own decision regarding whether or not it's for you, based on what you've read. I'll go into detail about the *Windows 95* operating system only when necessary.

Most of what you'll read is about decisions. After all, the final decision is up to you. For example, do you need or want to upgrade to *Windows 95*? It's your system and your money.

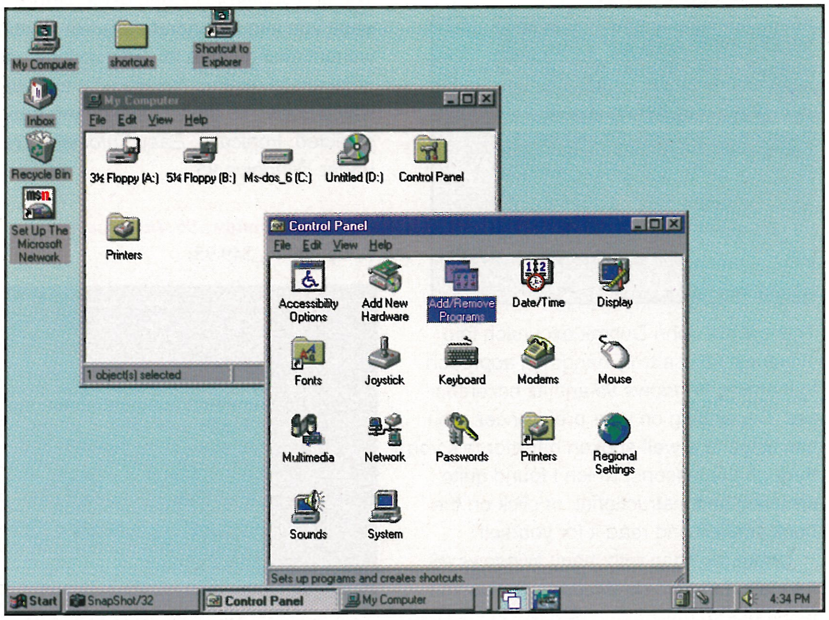


Fig. 1. *Windows 95* opens with a Desktop that includes My Computer, Inbox, Recycle Bin and Setup the Microsoft Network. If you're a LAN user you get Network Neighborhood, and notebook users will see My Briefcase.

New in *Windows 95*

Regarding why you may want to upgrade to *Windows 95*, you need to know what's hot and what's not. So let's look at what's new that might attract you.

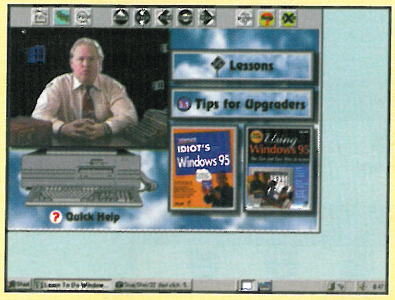
Freed from the limitations of DOS, *Windows 95* moves forward to create the definitive foundation for a new generation of easier-to-use, more-powerful 32-bit applications.

Comparing a 16-bit operating system to a 32-bit one is a lot like comparing a four-cylinder car to an eight-cylinder car. The four-cylinder engine has limited horsepower by comparison, which means the vehicle is generally a lightweight vehicle that's ideal for trips to the corner supermarket and picking up the kids from school. Nonetheless, it can be used—in a pinch—to fetch grandma, who lives two counties away, for Thanksgiving. The eight-cylinder engine, on the other hand, is generally found in grand touring cars, like a Cadillac or Lincoln Continental, that'll take you cross-country in speed and comfort but at the expense of higher fuel cost and greater maintenance costs. By this analogy, *Windows* 3.1 uses a four-cylinder engine, and *Windows 95* has an eight-cylinder engine.

Learning Windows 95

There's more to upgrading to *Windows 95* than just sticking in the disks and running the Setup program. Becoming familiar with the new operating system definitely requires some kind of tutorial. Here's a run-down on a number of software packages currently on the market to help you ease into this new operating system. This list is by no means all-inclusive. Rather, it's meant to provide representative examples of what you'll find on dealers' shelves and listed in catalogs.

Learn To Do Windows 95 *With John C. Dvorak* (Allegro, $39.95)

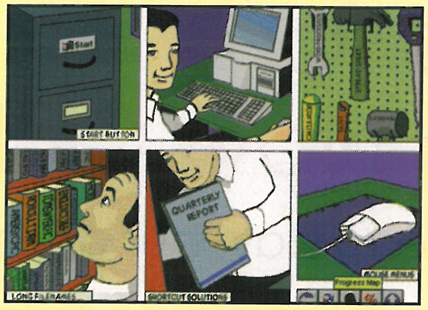


This cynical John Dvorak excursion into *Windows 95* is a truly hands-on approach to learning *Windows 95* and its eccentricities. Depending on your preferences, you can listen to a well-spoken narrator talk you through the lessons, which I found quite amusing and instructional, or click on the book version and read it for yourself.

Unlike the case with many *Windows 95* tutorials, *Learn to do Windows 95* lets you fast-forward, rewind and skip around. Moreover, the examples are real-world programs, like Microsoft *Excel*, instead of some esoteric application Allegro dreamed up.

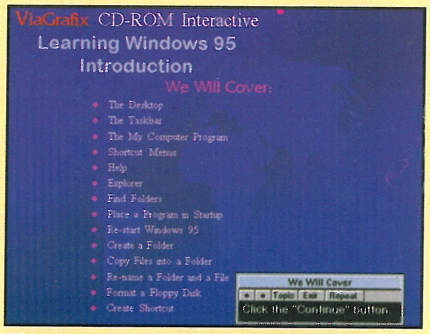
There's a lesson map that shows the whole lesson plan, from which you can pick and choose. Unfortunately, there are no canned interactions. Instead, you're asked to test your newly-learned skills in *Windows 95*, which can lead to more than a few crashes. In other words, you'd better be *Windows*-wise before you load this puppy. Moreover, this program appears to have been rushed to market to coincide with the release of *Windows 95*, and some of the screens are missing their video, and some tasks described are missing from the operating system. I'd wait for the next version.

Easy Tutor: Learn Windows 95 (CRT Multimedia, $40)



"Deep in the country, at Microsoft headquarters, serious brains have been researching..." is how *Easy Tutor* begins. Yes, this is a sales-pitch tutorial, but one that I like a lot. It addresses two levels of users: those who have never used *Windows* and experienced *Windows* users. The first, called Concept, uses cartoons to ease you into a general sense of *Windows* without telling you a lot. The serious user will want to explore the How-To tutorial, which goes into great detail on the topic selected. Ironically, *Easy Tutor* won't run under *Windows 95*.

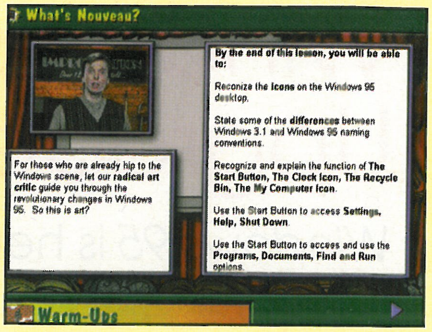
Learning Windows 95, *Introduction* (Viagraphics, $49.95)



This program teaches you everything you ever wanted to know about paper airplanes and make you sorry you asked because this pushy, non-interactive presentation is very much like a "Meet The Press" episode in which everything is canned and shallow. You can't fast-forward, which I found extremely annoying because it forces you to listen to the boring gal and guy TV news team *ad infinitum*.

This tutorial uses the traditional academic technique in which you're told what you'll learn, are given a lecture and then are provided a summary of what the professor just said. Boring. However, if you slog through it, you may learn something. There are better.

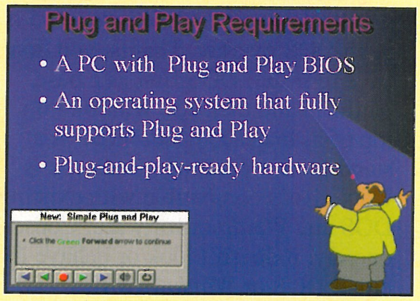
The Improv Presents Windows 95 *For the Technically Challenged* (Graphic Zone, $39)



Despite its visage, this isn't a funny program. It attempts to keep your interest and teach you at the same time. But its canned comedy skits are foreign to the topic on the screen, and the jokes aren't all that funny. While fast-forward and rewind functions are provided, you can't shut the comedian up once he gets started. If you can tolerate the "Saturday Night Live" scenario, you can actually learn something from this program.

There's an active index that has detailed information on almost anything you need to ask about *Windows 95*, and you're allowed to skip around from topic to topic.

Class Act (Soft One, $99.95)



Class Act is anything but a class act. The problem with this tutorial is that it's in complete control at all times. "Chatty Cathy," the woman narrator, has an inept voice that can't be shut up; the tutorials are canned and not interactive; and the fast-forward button forwards only the video part of the tutorial while Chatty Cathy drones on about the screen you just left.

If you're new to *Windows*, this may just be the ticket. No matter how hard you try to screw up things, *Class Act* takes over and performs the correct operation for you, using a rather large arrow to point out the steps involved. Too bad the tutorial is so canned that *Class Act* can't tell you what you did wrong.

Personal Trainer For Windows 95 (Personal Training Systems, $29.95)

Unlike most *Windows 95* tutorials, *PTS Personal Trainer* is totally interactive, which means that there are no canned routines. The tutorial is narrated by Peter Norton, of *Norton Utilities* fame, who introduces you to Liz, your personal trainer, and gives you an overview of each of its eight lessons. The lessons are basically divided into two

parts, elementary and advanced.

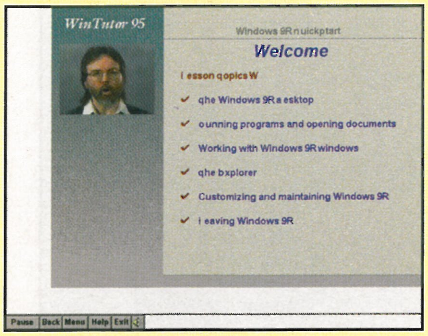
Early chapters are very elementary and describe mundane things like how to use a mouse (like you could have gotten there without the mouse already) and using the calculator. Fortunately, the latter lessons are packed full of facts and hands-on tips, and you can skip around.

In the lessons, you're given a problem to solve and Liz verbally tells you on what to click without an explanation as to why. Don't make a wrong move, though, because she keeps on going, and really quickly the sound is out of sync with the screen, forcing you to rewind and try again.

Some of the information is inaccurate, and some of the instructions are confusing. For example, asking you to click on your computer icon instead of the My Computer icon. Overall, though, this is one of the best tutorials I reviewed and the most-effective learning tool for the avid *Windows* user.

WinTutor 95

(SoftKey, $7.95)



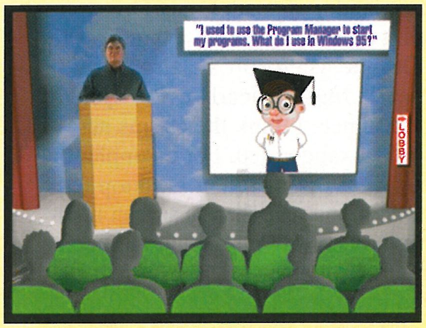
Yackety yak, don't talk back, pretty much describes what you'll find in *WinTutor 95*. This extremely vocal tutorial covers the gambit from neophyte to nerd, but it does it in such a way that you sometimes have to slog through a lesson you'd rather not hear to pick up a single skill. Worse, you can't fast-forward or shut up Jeremy, your tour guide.

Five course modules make up the package, beginning with how to use the computer and advancing to a quick take of *Windows 95* for the advanced *Windows* 3.1 user. You aren't forced to follow the regimen, and you can select the module of your choice. Unfortunately, once you start a lesson you have to put up with the yackety-yak until Jeremy lets you practice what he just preached.

This tutorial is extremely canned, practice sessions are barely interactive and most of the time you're sitting on your hands bored out of your mind.

Professor Windows 95 *Deluxe CD*

(Individual Software, $29.95)



This excellent tutorial works for all levels of uses and all levels of attention span. For the faint-of-heart or rambunctious, there's the theater, complete with a stand-up comedian who is actually very nerdy. He answers questions from the seated crowd about *Windows 95*.

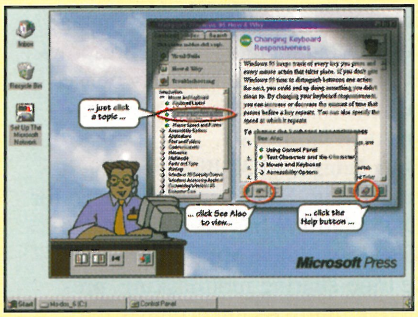
The questions are selected at random by clicking on a seat, and his response is both witty and accurate, though you may become very bored with "That's a good question" opening line. While this is a fun way to ease into *Windows 95*, topics covered are randomly selected, and few of the answers go into great depth.

For the real nitty-gritty, you must attend the *Windows 95* University Extension college, a virtual campus that teaches everything from using a mouse to object linking and embedding. While the lessons are canned, they're real-life experiences and so lively a that you'll be popping out of the tutorial to give what you just learned a try. This is my choice for a best-buy award.

How & Why Windows 95

(Microsoft, $19.95)

If your guess is that the best source for a *Windows 95* tutorial would come from the creator of *Windows 95*, you're wrong. The problem with *How & Why* is that you're lectured from start to finish, with no chance for a break or pause. Hopefully, you'll pick up something along the way from narrator Herb's fast-speaking voice. Thankfully, there's a rewind button so you can listen to



Herb over and over again until it finally sinks in.

The lessons are far too nerdy, with no foundation. And unless you're a very knowledgeable *Windows* user, you won't understand a word Herb says. Moreover, the same people who invented the Start button to stop *Windows 95* apply the same logic to *How & Why* in that the Back button moves you forward. Go figure. *How & Why* is for nerds only.

Introduction To Windows 95

(LearnKey, $29.95; $39.95 With Manual)

While *Introduction To* Windows 95 starts out user-friendly enough by describing the mouse and a couple basic tasks, it too quickly proceeds to advanced subjects without installing a proper foundation—a failing that leaves most beginners saying "huh?" Narrator Daniel Will-Harris sounds like my Latin professor, who talked endlessly on things I could care less about and used way too many lame jokes.

The speeches are lectures, the lectures are boring and the quizzes are dumb. Sometimes you have access to canned interactive routines. But far too often, you're simply launched into *Windows 95* to, hopefully, remember what Dan said and are left to fend for yourself. Fortunately, if you're a *Windows* 3.1 expert and not a beginner or average user, this tutorial can teach you a lot. It goes into nerd-ish detail about nearly everything, even things you don't want to know. There's an index of topics from which to choose, fast-forward and plenty of buttons to click on that may land you in never-never land.

According to the master plan, *Windows 95* promises to deliver this power on today's average PC platform while scaling itself to take advantage of additional memory and more-powerful PCs still in the blue-sky phase. The following are the key new features of *Windows 95*.

• **Fully-Integrated 32-Bit Operating System.** With *Windows 95*, the need for a DOS platform has been eliminated.

• **True Preemptive Multitasking.** Unlike time-sharing multitasking, preemptive multitasking arranges the PC's resources to meet the needs of the application with the most-immediate demands and delivers protection for applications that are temporarily relegated to the background.

• **Connectivity Support.** In addition to the controversial Microsoft Network, *Windows 95* has another avenue of access to the Internet using the Internet Explorer that ships with the extra-cost $50 *Microsoft Plus!* supplemental disk.

• **Support for 32-Bit Applications.** Like the difference between eight- and 16-bit applications, 32-bit applications (like *Microsoft Office for Windows 95*) are more powerful, run faster and are easily multitasked. However, they run under only a 32-bit operating system, most specifically *Windows 95* and *Windows NT*. Basically, the more bits an operating system can handle, the faster it runs.

• **Dynamic Environment Configuration.** Better known as Plug-n-Play, this *Windows 95* feature is able to read the "house" and see what cards the players are holding.

• **Extended Filenames.** With *Windows 95*, no longer are you limited to an eight-character file name. *Windows 95* lets you use up to 255 characters to define a file, albeit that only the first 11 characters appear on the Explorer screen.

• **Built-In Fax and E-Mail Messaging.** The Exchange client in *Windows 95* provides a single inbox for electronic messages, using the Microsoft Fax option.

If any of the above features captures your attention, *Windows 95* may be in the cards for you. Before you decide, though, you need to look very carefully before you leap. Despite Microsoft's claim, *Windows 95* isn't the definitive operating system, and some of your old *Windows* 3.1 friends have actually been abandoned. In the following sections, I'll give you the pros and cons of upgrading to *Windows 95* and describe what changes you may want to make to your system in terms of both hardware and software if you decide to take the plunge.

Before Installing *Windows 95*

Before upgrading to *Windows 95*, I used *Windows* 3.1, which I installed one time. As of this writing, I've now installed *Windows 95* at least 96 times, and it appears I may have to install it again because of system crashes.

Despite Microsoft's claim that *Windows 95* runs on nearly every system in existence, I think the claims are greatly exaggerated. For example, the Properties option under Desktop tells you that you can change screen resolution by simply clicking on an icon. This is altogether not true. When I tried to change from 800 × 600 to 640 × 480 screen resolution for a specific screen shot, *Windows 95* wouldn't let me do it.

When I questioned Microsoft technical support about the problem, the technician told me to uninstall *Windows 95*, run the *Windows* 3.1 setup program from DOS, choose the new video option from the setup menu and reinstall *Windows 95*. Does it never end? Here's what you need to know before installing *Windows 95*.

While Microsoft claims that *Windows 95* will run on a 386 system with 4M of RAM, think again. If you've seen *WinWord* 6.0 run on such a system, you'll agree there are better ways to while away your time. Moreover, though Microsoft claims that *Windows 95* runs as fast as or faster than *Windows* 3.1 on the same hardware, my testing of 16-bit applications reveals this claim to be true only if your PC has at least 16M of RAM. With 8M, most applications run noticeably slower. What you really need is a 486DX2 or better with 16M of RAM and 256K of cache. If your system isn't this powerful, consider *Windows 95* a good excuse to head to your local computer store and shop 'til you drop.

Windows 95 comes with a setup Wizard utility that facilitates installation. Unfortunately, the Wizard isn't as smart as he thinks he is. Sometimes his magic doesn't work. While many users will find they can just feed the floppies into their PC and have a flawless installation, others may stumble and actually crash along the way. Here are a few simple steps you

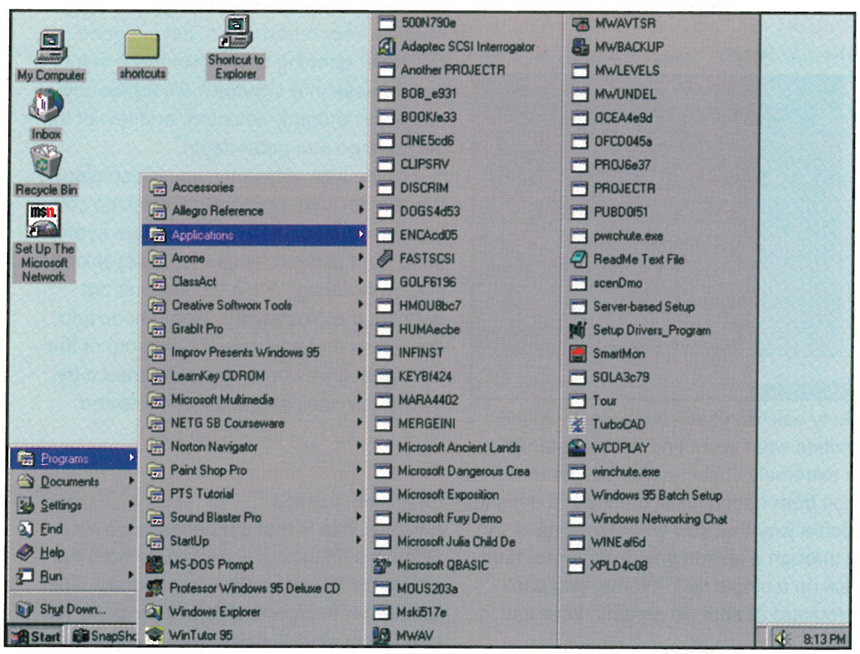


Fig. 2. Clicking on an operation generally opens other menus, like the Programs menu here. At the bottom of the screen is the Taskbar, which contains graphic representations of the open applications. To maximize one of these applications, you simply click on its icon.

should take to make sure *Windows 95* cooperates with your PC.

If you have a CD-ROM drive, buy the CD version of *Windows 95*. It's more compact, less messy and faster to install. In addition, it has some utilities you won't find on the diskette version. Another reason for buying the CD-ROM version is that you can often get a discount on *Microsoft Plus!*, the extra-cost $50 CD-ROM in the Microsoft Home series that contains the utilities Microsoft forgot to include in *Windows 95* in its haste to get to market "on time."

Make sure your hard drive has enough free room for the *Windows 95* installation. While the amount of disk space needed depends on the installation option you choose (Typical, Portable, Compact or Custom), you'd better have more than 50M available. Anything less, and you may as well stay with your DOS/*Windows* 3.1 environment. If you need extra disk space, you can reclaim it by removing old applications and games (which probably won't run under *Windows 95* anyway) that you haven't used in the last year.

Another option is to buy a large-capacity hard drive, which brings up new problems, like backing up your old hard drive (which you should do anyway) and transferring the data to the new hard drive. But be forewarned that if you're considering buying a 1G hard drive to run *Windows 95*, install it first under DOS and then install *Windows 95*.

The foregoing is basically the long and short of pre-install. The installation itself is rather painless, and proceeds smoothly. However, be aware that there are two versions of *Windows 95*. There's a Full Product version that you can install on any hard drive, whether or not you have DOS or/and *Windows* 3.x already on it. There's also an Upgrade version that requires *Windows* 3.1 or *Windows for Workgroups* 3.11 already installed to successfully load. The Full Product costs $100 more than the Upgrade version.

Now let's see how your system changes after *Windows 95* is installed.

Understanding the *Windows 95* Interface

The first thing you notice after installing *Windows 95* is that there's no DOS prompt. *Windows 95* itself *is* the operating system. No more typing in the WIN command at a DOS prompt or adding the C:\WINDOWS\WIN line to your AUTOEXEC.BAT file (in fact, *Windows 95* REMs out this line in your AUTOEXEC.BAT file). If you want to run a DOS program, you'll have to ask permission to do so of *Windows 95*. Depending on the application you choose, it may or may not run. I've certainly experienced my share of rejections.

Windows 95 opens with a Desktop (Fig. 1) that includes My Computer, Inbox, Recycle Bin and Setup the Microsoft Network. If you're a LAN user you get Network Neighborhood, and notebook users will see My Briefcase. These icons are really "radio" buttons that represent a *Windows 95* function. Clicking on one of these buttons opens up a whole world of options. For example, clicking on Network Neighborhood lets you browse the network, send and read e-mail or send faxes.

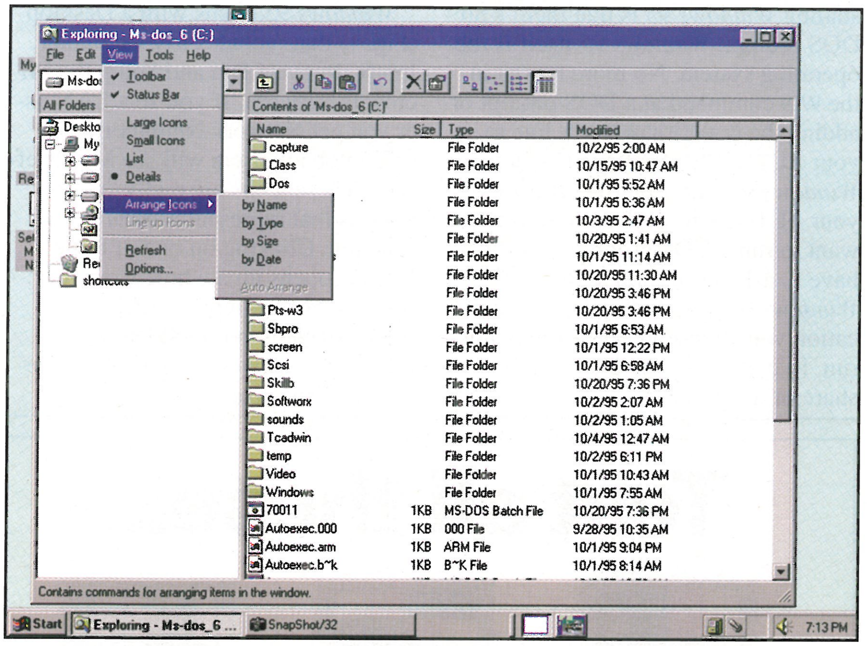


Fig. 3. When *Windows* 3.1 attempted to put things in order by offering a File Manager, this proved to be merely a Band-Aid device that created as many problems as it solved. This is why many *Windows* users migrated to *Norton Desktop for Windows*. In *Windows 95*, the file manager is called Explorer.

Let's look at each of these radio buttons in detail.

• **My Computer.** Taking a page from *Norton Desktop for Windows*, My Computer is a personal work area in which you can store your applications, files and project folders.

• **Inbox.** *Windows 95* comes with e-mail, fax tools and access to on-line services. You use Inbox to install these services on your system.

• **Recycle Bin.** A concept borrowed from the Macintosh, the Recycle Bin button allows you to trash files you no longer want or recover deleted files and return them to their original locations.

• **Microsoft Network.** When you click on this button, you install the controversial Microsoft Network, an on-line service designed to compete with America Online and CompuServe.

• **Network Neighborhood.** Clicking on this button lets you easily browse the network, regardless of which network provider is installed, be it *Windows NT Server*, *NetWare* or *Windows 95* itself.

• **Briefcase.** Clicking on this button allows you to update different versions of the same file stored on two different computers. You use it primarily to transfer files between your desktop and notebook computers.

In the lower-left corner of the main screen of *Windows 95* is an icon

(Continued on page 113)

By Greg Young

RS-485 In a Pinch

Under certain conditions, you can use an RS-485 port as an RS-232 port. Here's how.

Small projects never stay small. Invariably, features are added and new devices interfaced. Most good engineering provides room for this inevitable growth, but even the best laid schemes.... I have first-hand knowledge of the things that can go astray because while providing technical support for a manufacturer of single-board computers (SBCs), I spend my day solving such problems. One very common problem is adding RS-232 devices late in a project. Usually, by the time a project approaches its final stages, all available RS-232 ports are in use and the result is that the developer resorts to some expansion method. This solution eliminates the single-board simplicity and low cost the developer was originally seeking.

I'm usually surprised to find that engineers overlook a rather obvious solution—unused RS-485 ports. Before you say "that can't work," I'm aware that, strictly speaking, this is impossible. After all, RS-485 is differential 0 to 5 volts and RS-232 is single-line –12 to +12 volts and that it wouldn't work if everyone adhered to the standards. But, as Ross Perot says, "the devil is in the details."

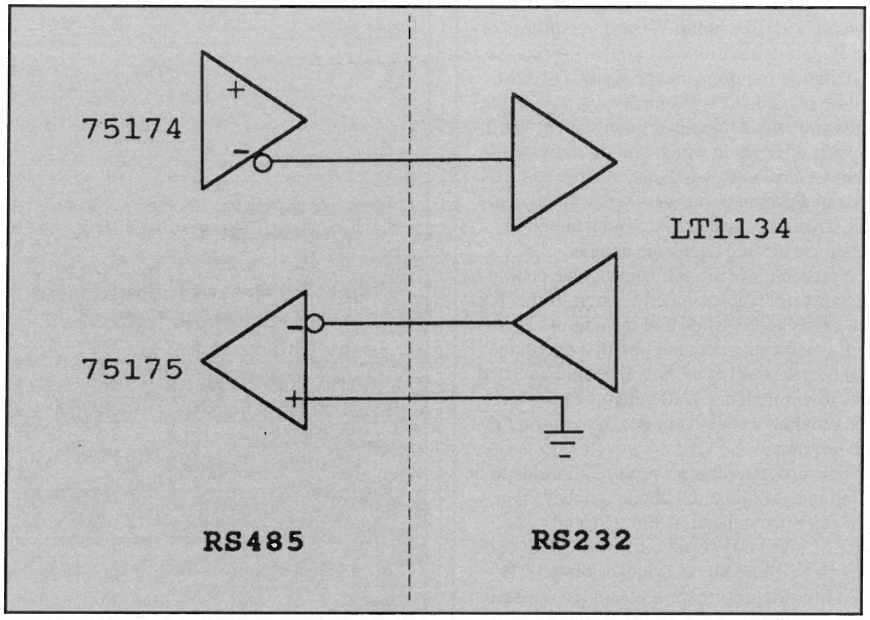


Fig. 1. Cross-connection details for RS-232 and RS-485 ports.

RS-485 to RS-232

I first got the idea when working with Hewlett Packard barcode readers. Even though they interfaced well with the RS-232 serial ports of the IBM PC, the specifications indicated the output was 0 to 5 volts. The manual made some reference to the fact that some serial ports might not work with this setup, but, for the most part, it wouldn't be a problem. Diving into the databooks, I discovered some interesting facts.

Even though RS-232 specifies a minimum swing of –3 to +3 volts, Texas Instruments' 1489, Maxim's MAX23x family and Linear Technologies' LT113x family transition at around 1.25 volts for RS-232 reception. While these receivers might have trouble with marginal RS-232 signals that conform to specification (noise in 1-to-2-volt region during transitions), they'll function perfectly well for reception of both clean RS-232 and TTL-level signals.

Great. Now you can receive TTL serial signals using an RS-232 receiver, but how does this help interface an RS-485 driver to an RS-232 receiver? The answer is simple. Even though an RS-485 driver has heavy drive capability and good electrical protection, in many ways it's nothing more than a complementary set of TTL drivers. When the driver's input is 0, the + output is 0 volt and the – output is 5 volts. When the driver's input is 1, the + output is 5 volts and the – output is 0 volt. Consequently, it's quite simple to use RS-485 for TTL serial communication.

You can connect the RS-485's – output to the RS-232's input. When the RS-485 driver's input is 0, its – output is 5 volts and the RS-232 should reproduce the 1 because its input is greater than the 1.25-volt threshold. Similarly, a 1 on the RS-485 driver produces 0 volt on the – output, which the RS-232 receiver will interpret as a 1 since it's less than the 1.25-volt threshold. You should have a good serial link, provided that the RS-232 receiver is willing.

RS-232 to RS-485

So far, you have unidirectional communications. While it's based on some sleight of hand, it will work in many circumstances and will be reliable. Fortunately, completing the loop of full bidirectional communications is more predictable. In fact, RS-232-to-RS-485 transmission works within the definition of the standards and doesn't rely too heavily on the specifications of particular chip manufacturers.

RS-232 represents a 0 by any potential between –12 and –3 volts with

Bits & Pieces

Making Contact

In business, it's often vital to contact clients by telephone. To assist you in this endeavor, Delorme offers *Phone Search USA* for *Windows 95* and *Windows* 3.1 that can put you in contact with more than 80-million individuals and businesses, quickly and efficiently. Its huge database spans three CD-ROMs labeled East, Central and West to accommodate the listings.

Phone Search USA installs from *Windows*. When you install this 32-bit program, it steps you through the installation procedure using a *Windows 95*-like Setup Wizard, regardless of the *Windows* environment you're using. Installation requires just the East CD-ROM.

When you launch *Phone Search USA*, it presents you with a three-part main screen. Part 1 consists of fields in which you fill in the name, address, city, state, telephone number and ZIP code of a person or business you want to contact. Then you click on the Search button to obtain the desired telephone number.

You can enter the full name of the person or business or an abbreviated version. If this person exists and is listed and the address is correct, you may or may not obtain a telephone number, depending on how the name is listed and how it matches your entered data. So if you obtain a no-match notice, try entering just the last name.

This program doesn't require all fields to be filled in to obtain a telephone number. You can enter just a name, fill in just a city and state or just a city or a state or just a ZIP code. Search will find all occurrences on the CD-ROM for the information you enter. You can even search the entire database, swapping in and out the CD-ROMs.

The more fields you fill in, the narrower and faster the search and the fewer the number of results returned. If you fill in only a name or a city or a state or a ZIP code and click on Search, you obtain all listings on the entire CD-ROM for the information you entered.

The program also provides a reverse directory. Typing in a telephone number in the Phone field and clicking on Search provides the name and address of the person or company for that number.

If you're searching for the telephone number of a specific type of business, you can click on the SIC (Standard Industrial Classification) button to bring up another screen that displays the SIC numbers for a wide variety of industry types. In the Search for: field in this screen, you enter the type of business that interests you, and if a code for it exists, it will be highlighted in the main window. Alternatively, you can scroll through the offerings provided in the main window to find the type of business for your search, click on it to highlight the entry and then click on the Select button at the bottom of the window.

Once you click on Select, the SIC screen closes and the selected code is automatically entered in the SIC field on the main screen. Fill in any one or more remaining fields in the main screen and click on Search to obtain a listing of all businesses in this category defined by your entries.

(Continued on page 58)

Listing 1. Test Program For Bidirectional Test of RS-485 to RS-232 Connection at 57,600 Baud

```
/******************************************************************************\
  Test BiDirectional RS485 - RS232 Connection at 57600 Baud
    On Little Giant, Connect :
      J8(3) - J9(4)  [RS232 Xmit to RS485 - Input ]
      J8(9) - J9(5)  [Ground      to RS485 + Input ]
      J8(5) - J9(2)  [RS232 Recv to RS485 - Output]
\******************************************************************************/

char message[] = "Echo... Echo... ";

void
Echo    ( void (*send)(),          // Transmit Function
          void (*recv)()    // Receive Function
          )

{ int timer;                                      // Timeout Counter
  char rcnt,tcnt;                                 // Recv/Send Counters
  char buffer[32];                                // Test Buffer

    tcnt = rcnt = strlen ( message );             // Message Length
    memset ( buffer,0,rcnt+1 );                   // Clear Buffer
    recv ( buffer,&rcnt );                        // Setup Reception
    send ( message,&tcnt );                       // Send Message
    for (timer=0x2000;--timer && rcnt;);          // Wait for Exchange
    if (! timer)                                  // Timeout?
      printf ( "Timeout " );
    else if (strcmp ( buffer,message ))           // Error?
      printf ( "<%s|%s> ",buffer,message );
}

void
main        ( void
            )

{ int cycles;
  char buffer[32];

    setdaisy ( 1 );                               // Set KIO Priority Diasy Chain
    ser_init_s0 ( 4,57600/1200 );                 // Initialize RS232 Port
    ser_init_s1 ( 4,57600/1200 );                 // Initialize RS485 Port
    outport ( ENB485,1 );                         // Enable RS485 Driver

    for (cycles=0;;cycles++) {                    // Infinite Test
      printf ( "\n%5d ",cycles );                 // Show Working
      Echo ( ser_send_s0,ser_rec_s1 );            // Test One Way
      Echo ( ser_send_s1,ser_rec_s0 );            // Test The Other
    }
}
```

respect to ground. Similarly, a 1 is represented by any potential between 3 and 12 volts with respect to ground. Without some additional hardware (such as a couple of diodes), there doesn't seem to be too much 0-to-5-volt potential here—and there isn't.

RS-485 receivers determine the state of a twisted pair by the difference in the voltages (hence the term differential). If the – input exceeds the + input, the signal is a 0. Likewise, if the + input exceeds the – input, the signal is a 1. In most receivers, there's actually a threshold that each difference must exceed before the receiver switches states. In the 75174 from TI, for example, this threshold (or hysteresis) is 0.2 volt.

This shows promise, except for one

fact. RS-485 is basically fancy TLL and RS-232 is bipolar. Usually, this is a poor combination. But remember that RS-485 is a robust standard, used mainly for industrial control. As such, it has all sorts of protection specified in the standard. The 75174, for example, specifies the minimum –12- to +12-volt common-mode input range. In plain English, the signals can drift anywhere within this range and their differential still be determined. This is your light at the end of the tunnel.

All you need to do is connect the output of the RS-232 transmitter to the – input of the RS-485 receiver and ground to the + input of the RS-485 receiver. When the RS-232 outputs a 0 (+12 volts), the – input exceeds the + input (at ground) and the RS-485 reproduces the 0. When the RS-232 outputs a 1 (–12 volts), the + input exceeds the – input and the RS-485 reproduces the 1.

If such an arrangement offends your good engineering sense, take heart. A number of industrial control companies (whose bread and butter is reliability) use this technique to permit RS-485 receivers to double as RS-232 receivers. They still use RS-232 transmitters when needed because its connection is less predictable. But, as I've already noted, RS-485 will do in a pinch.

This is Only a Test

I've used this technique myself on occasion and suggested it to dozens of others in trouble, but no paranoid worth his salt would make such an audacious suggestion without providing proof. Taking my Little Giant controller, I quickly cross-connected the RS-485 and RS-232 as described above (see Fig. 1). Interestingly enough, this connection requires three wires—the same as the typical minimum connection between RS-232 ports. Then a quick program (see Listing 1), and my point is proved, at least for the LT1134 RS-232 transceiver and 75174/75175 RS-485 drivers/receivers used on the Little Giant. Your results may vary.

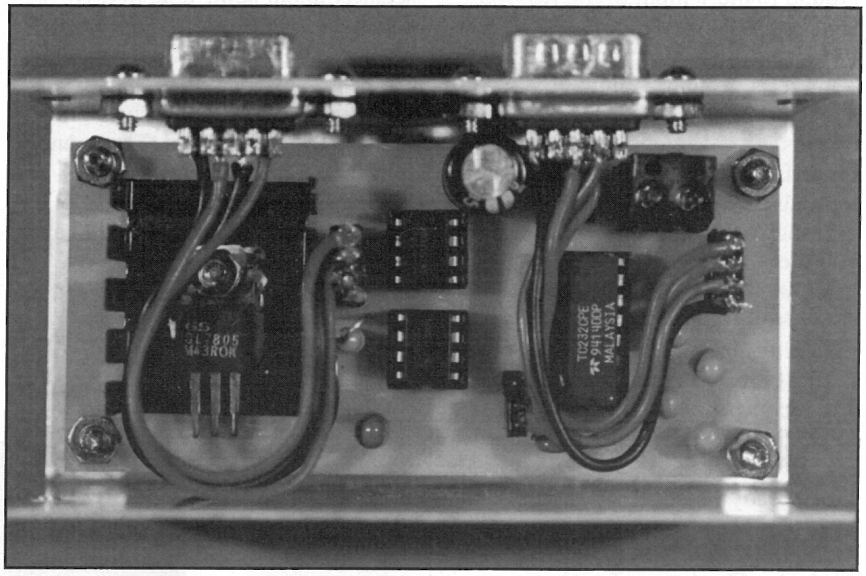
Keep in mind that the ability to use this link relies almost entirely on design and chip selection. So while you can't count on using this technique in general, you can rely on it when two know quantities are involved. For example, if you're supplying a generic port for modem connections, don't use RS-485 hardware for your interface. You can't be certain what design the modem will use. On the other hand, if you're also supplying the modem to your customer and know that Brand XYZ modems work, it's generally safe to use this technique with this particular modem.

Be sure, too, to consider this connection an RS-232 connection. Just as a chain is only as strong as its weakest link, this connection is severely limited by the RS-232 drivers and receivers. Presence of RS-485 hardware mustn't lull you into a false sense of security about being able to drive signals over long distances. In fact, the inability of RS-232 receivers to handle common-mode offset makes this link slightly less reliable than a normal RS-232 connection. The connection should be fine over short distances (6 feet or less), reasonable baud rates (57,600 and less) and away from harsh environments (power saws, superconducting magnets, plasma welders,etc.).

By Duane M. Perkins

Getting to Know the RS-422/485 Standard

What you need to know to increase communicating distance and an RS-232-to-RS-422/485 converter you can build



Industry standards are what make modern universal personal computing possible. The RS-232 standard ("RS" stands for "recommended standard"), for example, has been around for so long and is so widely used that most readers of *MicroComputer Journal* are familiar with its specifications for signal-voltage levels. Under it, a receiver must accept a signal level of 3 volts or greater as valid. A positive level is logic 0, and a negative level is logic 1.

Due to the high source impedance of several thousand ohms and the fact that the signal level is referenced to a common ground, long communication lines are subject to noise induced by electromagnetic and electrostatic fields. As a general rule, a run of more than 100 feet is inadvisable with the RS-232 standard.

The more-recent RS-422 standard overcomes the distance limitations of RS-232 by using differential transmitters and receivers and a pair of conductors for each signal.

In this article, I'll discuss the criteria of the RS-422/485 standard. In addition, I'll describe how to build a simple RS-232-to-RS-422/485 Converter you can build and put to use to increase your reliable communicating distance.

Design Rules

Under the RS-422/485 standard, the logic condition is determined by the difference in the voltage levels on the conductor pair. At the transmitter, one conductor of a pair is at near +5 volts, the other at near ground level (the same as for TTL levels). The logic is reversed by reversing the voltage levels on the pair.

The 75176 chip was developed to interface an RS-422 line to a TTL input (receiver) or output (transmitter). Of the two pins of the transmitter/receiver that connect to the signal pair, one is noninverting (+) and the other is inverting (–). When receiving, the TTL output follows the + input. When sending, the + output follows the TTL input. A logic 1 is indicated by making the + pin high, and a logic 0 is indicated by making the – pin high.

The transmitter has a low source impedance. The line should be terminated by a low-value resistor in the range of about 150 ohms at the receiver. Noise induced in the line affects both conductors in the same manner so that little or no change in the difference appears at the receiver.

A small change in the current due to noise won't significantly affect the voltage levels at the receiver and, thus, won't be seen as a change in the logic condition. A common ground conductor is neither required nor desirable, since it would only pick up noise. The signal is reliable over a run of thousands of feet at very high baud rates.

RS-485 specifies the same voltage levels as RS-422. The difference is that RS-485 provides for half-duplex communication on a single pair, whereas RS-422 requires two pairs for full-duplex communication. The 75176 has two control pins that enable reception and transmission. If the two pins are tied together, the chip is in receive mode when the control voltage is at TTL low or in send mode when the control voltage is at TTL high. This permits reversal of signal direction under program control in half-duplex operation.

Needless to say, the devices (computers) that are communicating with each other must be coordinated so that only one is sending and the rest are receiving. Provided that appropriate coordination is programmed into all devices, any reasonable number of computers or devices can be connected via a single conductor pair. There

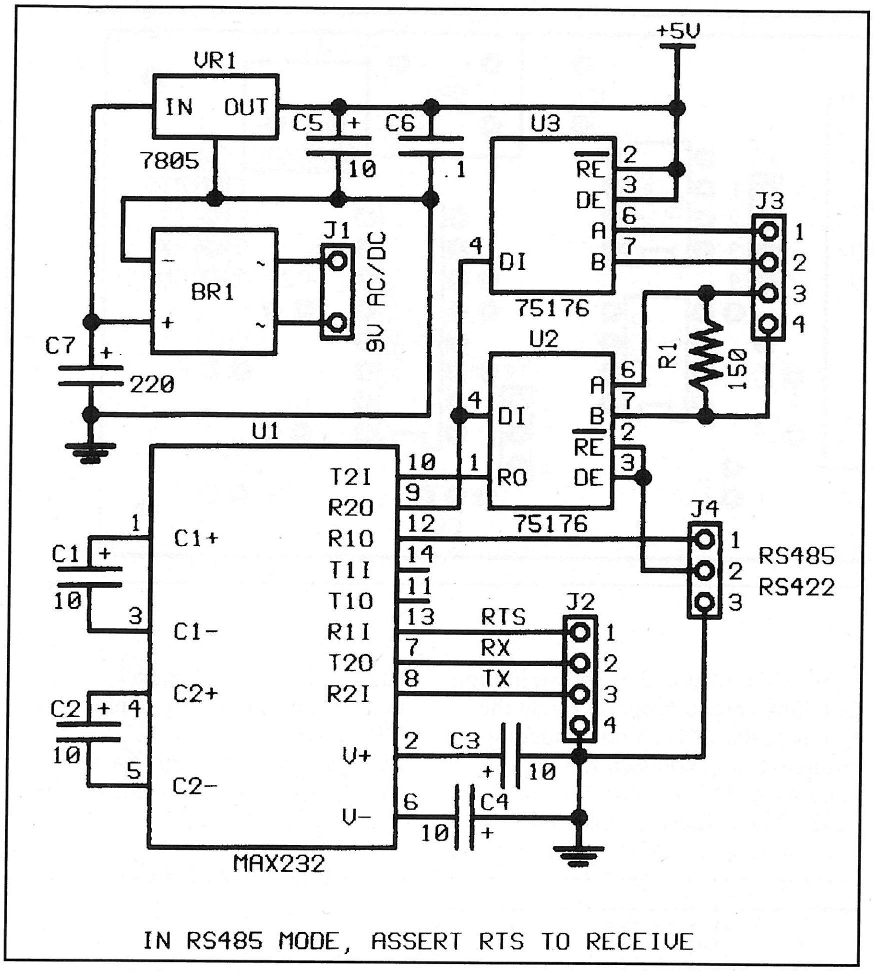


Fig. 1. Complete schematic diagram of circuitry for RS-232-to-RS-422/485 Converter.

PARTS LIST

Semiconductors
U1—MAX232CPE
U2,U3—75176
BR1—VM08 bridge rectifier
VR1—7805 +5-volt regulator in TO-220 package

Capacitors
C1 thru C5—10-µF, 16-volt tantalum
C6—0.1-µF monolithic
C7—220-µF, 35-volt electrolytic

Resistors
R1—150 ohms, 1/2-watt

Miscellaneous
J1—Two-position printed-circuit connector
J2,J3—Single-row four-pin header
J4—Single-row three-pin header
Printed-circuit board; 9-volt dc 300-mA ac adapter; heat sink (Radio Shack Cat. No. 276-1363) for VR1; DIP sockets for ICs; jumper block for J4; suitable enclosure (see text); machine hardware; hookup wire; solder; etc.

should be two terminating resistors, one at each end of the line—not one at each terminal.

RS-232 was developed with the aim of connecting terminals to modems. Accordingly, it specifies several control-signal lines that indicate modem and terminal status. The RS-422/485 standard was developed to connect computers and terminals directly via hard conductors, rather than modems. Hence, control lines aren't required with RS-422/485, although some serial-port cards provide for use of RTS to control signal direction in RS-485 operation.

The Converter

Although RS-422/485 serial ports are available for PCs, they aren't as common as RS-232 ports. An alternative to adding one is to build a device that converts the signals in both directions, permitting use of RS-422/485 communication with an existing RS-232 port in the computer. Show in Fig. 1 is the schematic diagram for such a Converter.

This Converter uses a MAX232 and two 75176s. Power is provided by a bridge rectifier, filter capacitor and 7805 voltage regulator. The power source connected to J1 can be either ac or dc and can have a rating of 6 to 9 volts ac or 9 to 12 volts dc. An adapter rated for 9 volts dc at 300 mA is a good choice.

Connection to the RS-232 lines is accomplished with J2. Similarly, J3 connects to the RS-422/485 lines. Pins 1 and 2 aren't used in RS-485 operation. You must jumper J4 for either RS-422 or RS-485 operation. In RS-485 operation, signal direction is controlled by the voltage level on pin 1 of J2. Although this is labeled RTS, it could as well be DTR. When this line is asserted (positive), R1O is low and *U2* is in receive mode. When this line is dropped (negative), R1O goes high and puts *U2* in send mode.

Construction

Shown in Fig. 2 is the actual-size etching-and-drilling guide (solder side) for fabricating the printed-circuit board for the Converter. This

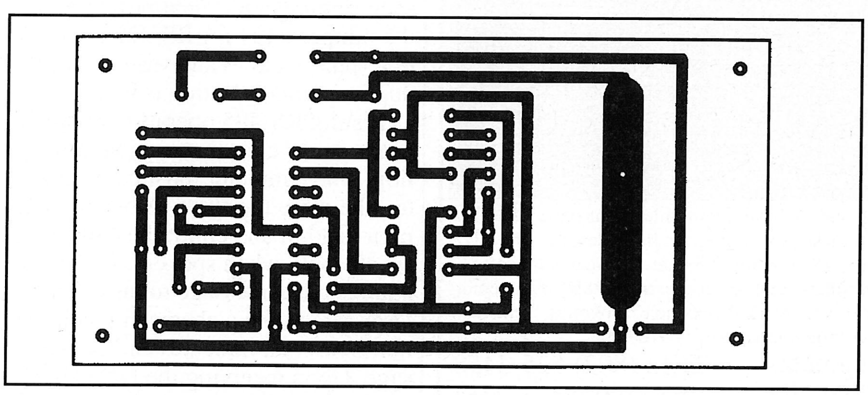


Fig. 2. Actual-size etching-and-drilling guide to use for fabricating printed-circuit board.

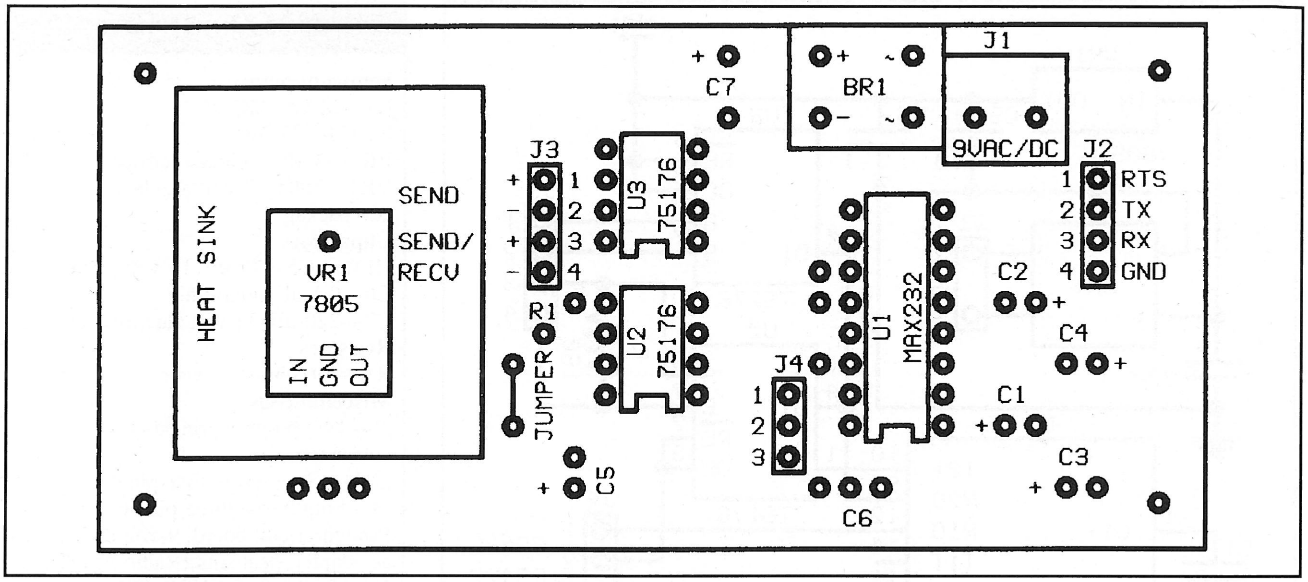


Fig. 3. Wiring guide for pc board.

board fits inside a Radio Shack Cat. No. 270-239 enclosure. If you prefer not to fabricate a pc board, you can assemble and wire the circuitry on a piece of perforated board that has holes on 0.1" centers, using suitable Wire Wrap or/and soldering hardware.

Wire the pc board as shown in Fig. 3, taking care to properly orient the components. J1 is a two-conductor printed-circuit connector. You can mount two DB-9 connectors on one side of the enclosure and connect them to J2 and J3 with cables terminated with four-pin header connectors made by cutting in half an eight-pin DIP socket.

Connections between J2 and its mating DB-9 connector (male or female) are as follows:

J2 Pin	DB-9 Connector
1	7
2	3
3	2
4	5

There's no standard for RS-422 connections to a DB-9. Select your own pins for the connections to J3.

Testing

The circuit is so simple and construction is so easy that not much can go wrong if care is taken to make sure all solder connections are good and that there are no solder bridges. Testing requires an RS-422 device or two converters. Assuming two computers, each running a terminal program, set the jumper on J4 for RS-422 operation (pins 2 and 3) and verify that full-duplex communication is working.

Testing RS-485 operation requires programs to coordinate signal direction. One computer must be the master, the other the slave. A better metaphor is adult and child; the child speaks only when spoken to. The adult sends a message to the child, terminated with a character (such as a null byte) that indicates end-of-message. Upon receiving the EOM character, the child responds by sending a message to the adult, which also ter-

Listing 1. C-Code For Adult

```
/* adult.c */
#include <stdio.h>
#include <time.h>
#include <bios.h>
#define port 1 /* COM port number */
#define params _COM_CHR8|_COM_STOP1|_COM_NOPARITY|_COM_1200
clock_t clock(void);
main()
{
    Union {
        unsigned far *data;
        long address;
        } bios;
        clock_t delay,target;
        unsigned datareg,contreg,statreg,i,k;
        Delay = CLK_TCK/(clock_t)10; /* 100 ms */
        bios.address = 0x400 + 2*(port-1);
        datareg = *bios.data;
        contreg = datareg + 4;
        statreg = datareg + 5;
        _bios_serialcom(_COM_INIT,port-1,params);
        inp(datareg);
        while(!kbhit()) {
            for(i=1;i<=9;i++) {
            if(kbhit()) break;
            putchar(i|0x30);
            putchar(' ');
            outp(contreg,0);
            while(!(inp(statreg)&0x20));
            outp(datareg,i);
            while(!(inp(statreg)&0x40));
            outp(contreg,2);
            for(;;) {
                target = clock() + delay;
                while(clock()<target)
                    if((k=inp(statreg)&1)) break;
                if(!k) break;
                k = inp(datareg);
                if(k) putchar(k);
            }
            putchar('\n');
        }
    }
    getch();
}
```

minates with an EOM character.

Certain considerations when communicating via half-duplex must be observed. The receiver must wait until the sender has switched to receive before it switches to send. A delay of perhaps 100 to 1,000 µs after receiving the EOM character should be sufficient. After the sender switches to receive, it must wait at least as long as the delay before the former receiver switches to sender and sends the first character.

The sender must wait until the EOM character has actually been sent (not just stored in the output data register) before switching to receive. This can be accomplished by a shorter delay to assure that the switch occurs before the other terminal switches to send.

A better way is to monitor Bit 6 of the line status register in the UART. When it's set, the transmitter shift register is empty.

With multiple child terminals operating in half-duplex, some means of polling is required. Each child must be assigned an identification code that it recognizes. For example, assume that the first character of every message sent by the adult is the ID number and is never 0 (the EOM character is a null byte).

All children receive the message, but only the one for which it's coded is to respond. The adult can either wait briefly for the child to respond and assume there's nothing to report if a message isn't received promptly, or all children can be programmed to send a null byte if there's nothing to report.

Listings 1 and 2 contain the C code

Bits & Pieces *(from page 52*

Making Contact

In part 1 you can select both residential and business or either of the two for your searches. Activating only one of these, again, narrows the search and reduces the time and number of results returned.

When not grayed-out, you can click on More to obtain additional matches in the Search Results window. Matches are otherwise limited to 500. Clicking on New Search clears all fields in all parts of the main screen.

Selections Part 3 of the main screen consists of a window in which you list all the results of your searches and a series of eight buttons. To place any one or more search results in this window, you highlight it in the Search Results window and click on the Add button. To add all search results, click on the Add All button. If you want full details about the result of a search, click on the Full Info... button to see all fields in the part 1 area filled in.

Along the bottom of the Selections window are five buttons. Export brings up a screen that allows you to export an unlimited number of listings. After performing your searches, you can export all of them or just highlighted ones from either the Search Results or Selections window. You can limit the number of listings to export to 100 by clicking the Limit to box.

Exporting can be to a disk file you specify in the text box (or to a file you choose from those available when you click on the Browse... button) or to the *Windows* clipboard, from which you can paste the export listings into a word-processing document, database, etc. A Format area in the Export screen lets you choose from Commas, Commas with Headers or Tabs. Once you've made all your selections, you click on the Export button, the action occurs and you're returned to the main screen.

Clicking on the Count button brings up a dialog box that tells you the total number of searches performed. If you've installed Delorme's separate companion *Street Atlas USA* program, clicking on the Map button below the Selections window lets you find the location of the party of interest on a map.

Clicking on the Remove and Remove All buttons at the bottom of the Selections window initiates exactly the opposite actions of the Add and Add All buttons at the top of this window.

I really like the flexibility built into *Phone Search USA*. With it, I can search for a telephone number by typing in the full name, address and ZIP code of the person or company I want to contact and usually be assured of obtaining the telephone number I need. Every search I've initiated using *Phone Search USA* has been speedy on my Pentium 90 with 2x CD-ROM drive, and having three small CD-ROMs to juggle wins hands down over a room filled with hard-copy telephone directories.

Phone Search USA, $79
Delorme
Lower Main St.
PO Box 298
Freeport, ME 04032
Tel.: 1-800-452-5931 or 207-865-1234; fax: 207-865-9291; WWW:
http://www.delorme.com

Listing 2. C Code For Child

```
/* child.c */
#include <stdio.h>
#include <time.h>
#include <bios.h>
#define port 1 /* COM port number */
#define params _COM_CHR8|_COM_STOP1|_COM_NOPARITY|_COM_1200
#define id 5 /* terminal ID */
char message[] = “TERMINAL n”;
clock_t clock(void);
main()
{
    union {
        unsigned far *data;
        long address;
    } bios;
    clock_t delay,target;
    unsigned datareg,contreg,statreg,i,k;
    message[9] = id|0x30;
    delay = CLK_TCK/(clock_t)100; /*10 ms */
    bios.address = 0x400 + 2*(port-1);
    datareg = *bios.data;
    contreg = datareg + 4;
    statreg = datareg + 5;
    _bios_serialcom(_COM_INIT,port-1,params);
    inp(datareg);
    for(;;) {
        outp(contreg,2);
        while(!((k=inp(statreg)&1))) if(kbhit()) break;;
        if(!k) break;
        k = inp(datareg);
        putchar(k|0x30);
        putchar(‘ ’);
        if(k==id) {
            target = clock() + delay;
            while(clock()<target);
            outp(contreg,0);
            for(i=0;;i++) {
                while(!(inp(statreg)&0x20));
                outp(datareg,message[i]);
                if(!message[i]) break;
            }
            while(!(inp(statreg)&0x40));
        }
        putchar(‘\n’);
    }
    getch();
}
```

for an adult and child, respectively. The adult polls for ID codes 1 through 9. After sending an ID code, the adult waits 100 ms for a response from that child. Each child receives the ID code from the adult. The one with a matching ID waits 10 ms to be certain the adult has switched to receive and then sends a string of bytes that identify itself.

The adult displays the string. When 100 ms have elapsed with no character received, the adult proceeds to poll the next child. This delay assures that the child has switched to receive mode before polling resumes.

Port number can be 1, 2, 3 or 4, corresponding to COM1, COM2, COM3 or COM4. Using DEBUG to display memory at 40:0 shows the port addresses of up to four installed serial ports. Each address is shown as two bytes, with high-order byte following low-order byte (3F8 is shown as F8 03). The first two bytes contain the address for COM1, the next two for COM2, etc. If the address is 0, the corresponding port isn't installed.

Because of the obvious superiority of RS-422/485 over RS-232 for long distance hard-wired serial communication, it will no doubt come into wider use, and serial ports that incorporate it will become more common. For the present, you can use the Converter described to accommodate existing RS-232 ports.

If you have questions or comments, you can contact me during Eastern daytime hours at 717-964-3536. ■

By Paul Bergsman

Acquire 12- and 16-Bit Data From a Parallel Printer Port

The A/D converter projects described here are all you need to do this effortlessly

While you might think that the parallel port on your PC is for printing-only operations, you should be aware that you can actually use such ports to *acquire* data as well. In this article, I'll provide you with the theory, tested circuits and related software so that you can build a 12-bit analog-to-digital (A/D) converter to interface to your PC through any IBM/compatible parallel printer port. I'll also give information that will let you use the same techniques to input nine-to-16-bit data through your parallel printer port.

A/D Converter Problems

There are basically four good reasons for using an eight-bit A/D converter, among them, speed, chip size, circuit-board complexity and cost. Before you get started, though, it's important that you be aware of the negatives related to large-bit converters before you jump right on in and start building the circuits I'll describe later.

Let's look at speed first. An eight-bit converter divides its reference voltage into 256 parts, a 12-bit converter into 4,096 parts. By going from eight to 12 bits, resolution is increased 16-fold. If both converters use the same conversion technique, it will take longer to convert the larger 12-bit sample.

During conversion, the input voltage value may change. To help assure an accurate reading, some converters use track-and-hold to first garb and store a sample and then take the time needed to digest the information.

Going to a 16-bit converter increases resolution to 256-fold over its eight-bit counterpart. Therefore, the 16-bit converter will be proportionately slower still.

Regarding chip size, a 12-bit parallel output converter needs 12 output pins for the 12 output bits, more pins for control signals and still another pin for a negative supply voltage. The added pins translate into a physically larger IC that takes up more board space, which could present problems when size is an important factor in designing a circuit. In addition, the chip will probably require more support circuitry that also takes up board space.

With 12-bit resolution, grounding and input noise also become important design factors. Proper grounding may require additional board space. Additional filtering may be needed to reduce noise, again increasing parts count and, thus, board space.

Lastly is cost. It's much more difficult to divide a reference voltage into 4,096 parts with a 12-bit converter than it is to divide it into 256 parts with an eight-bit converter. The 12-bit chip contains not only more circuitry, but circuitry made up of precision parts, and precision parts cost money. Track-and-hold, a precision reference and temperature-compensation circuitry all add to the chip's complexity and to the cost of implementing a circuit design.

Noise must also be taken into consideration. You must carefully design your circuits to eliminate noise from their inputs. These design considerations and the added circuit-board components will be reflected in a higher-priced circuit-board assembly.

Remember, too, that with more parts it's more likely that something can go wrong. All these problems are compounded with 16-bit devices. So your best solution is to use only the resolution your project requires. Keep the circuit simple!

With all this said, there are good reasons to use high-resolution A/D converters. For instance, if you want to make a 16-bit audio recording, you must use 16-bit A/D converters. Alternatively, suppose you want to monitor a strain-gauge sensor. The sensor's output is adjusted to vary between 0 and 5 volts. However, yesterday's readings varied between 0 and 0.6 volt and today's readings varied between 4.6 and 4.9 volts. Add this to fact that you're not sure what tomorrow's spread will be.

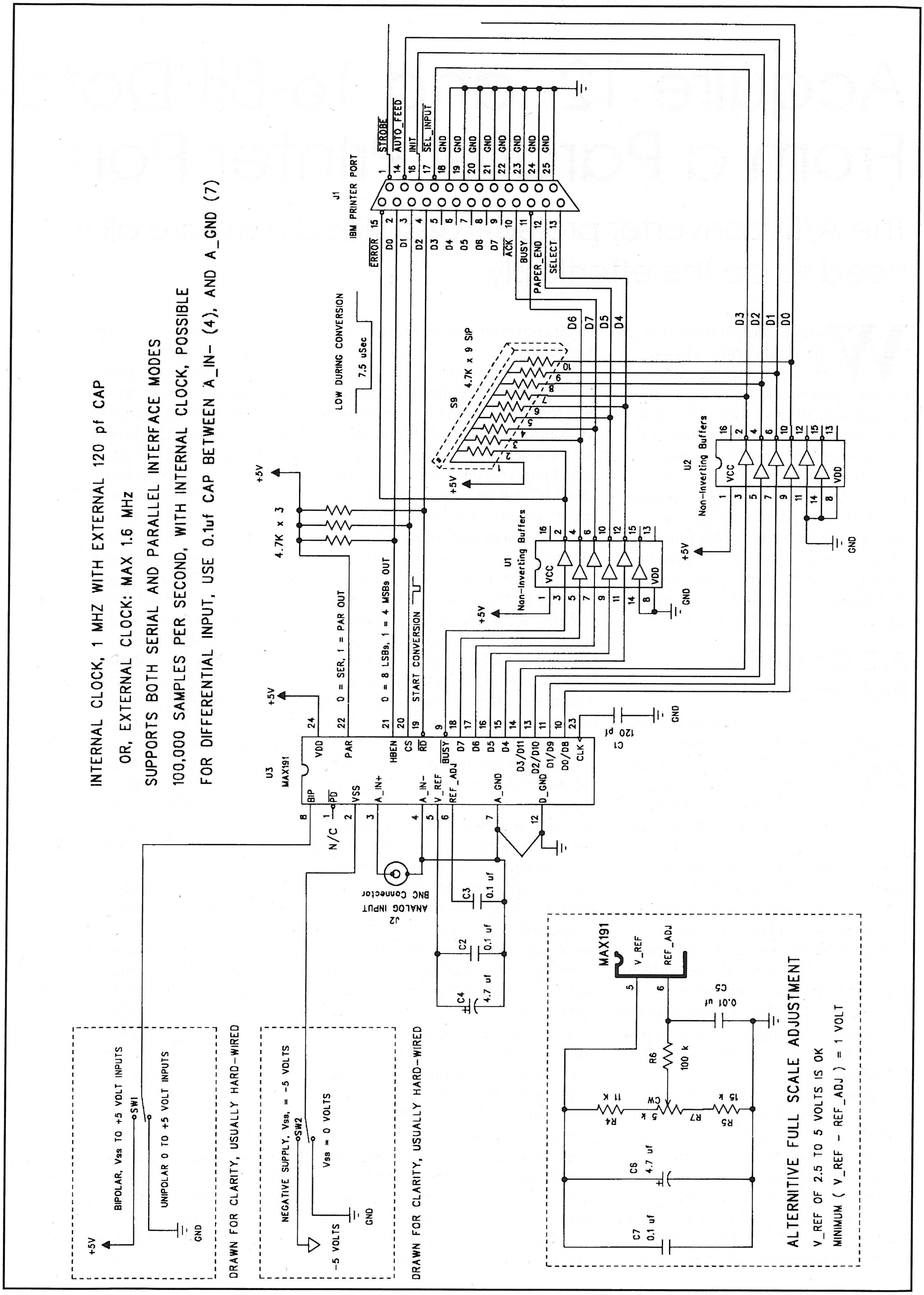
You could re-calibrate your equipment each morning, (if you had some idea what the day's range would be) or you can divide the 5 volts into enough parts that you always obtain meaningful readings, regardless of the input's voltage swing.

Some appropriate applications for 12-bit A/D converters are:

- High-school and college science experiments
- Engineering students' projects
- Battery-powered data logging
- PC pen digitizer
- High-accuracy process control
- Electrochemical systems
- Data-acquisition cards for PCs
- Automatic testing systems
- Telecommunications
- Digital signal processing

I'll show you how to build single-channel and an eight-channel A/D converters, using the MAX191 and MAX180, respectively. Both chips provide multiplexed parallel outputs that permit them to be easily connected to an eight-bit interface device. (The IBM/compatible parallel printer port is an eight-bit I/O device.)

Presented here are basic circuits



INTERNAL CLOCK, 1 MHZ WITH EXTERNAL 120 pf CAP
OR, EXTERNAL CLOCK: MAX 1.6 MHz
SUPPORTS BOTH SERIAL AND PARALLEL INTERFACE MODES
100,000 SAMPLES PER SECOND, WITH INTERNAL CLOCK, POSSIBLE
FOR DIFFERENTIAL INPUT, USE 0.1uf CAP BETWEEN A_IN- (4), AND A_GND (7)
LOW DURING CONVERSION
7.5 uSec
J1
IBM PRINTER PORT
S9
4.7K x 9 SIP
4.7K x 3
U1
Non-Inverting Buffers
U2
Non-Inverting Buffers
U3
MAX191
0 = SER, 1 = PAR OUT
0 = 8 LSBs, 1 = 4 MSBs OUT
START CONVERSION
C1
120 pf
J2
ANALOG INPUT
BNC Connector
C3
0.1 uf
C2
0.1 uf
C4
4.7 uf
BIPOLAR, Vss TO +5 VOLT INPUTS
UNIPOLAR 0 TO +5 VOLT INPUTS
SW1
DRAWN FOR CLARITY, USUALLY HARD-WIRED
NEGATIVE SUPPLY, Vss = -5 VOLTS
SW2
Vss = 0 VOLTS
-5 VOLTS
DRAWN FOR CLARITY, USUALLY HARD-WIRED
MAX191
V_REF
REF_ADJ
C5
0.01 uf
R6
100 k
R4
11 k
R7
5 k
R5
15 k
C6
4.7 uf
C7
0.1 uf
ALTERNITIVE FULL SCALE ADJUSTMENT
V_REF OF 2.5 TO 5 VOLTS IS OK
MINIMUM (V_REF - REF_ADJ) = 1 VOLT

PARTS LIST

For MAX191

Semiconductors

U1,U2—4050 noninverting buffer
U3—MAX191 12-bit A/D converter

Capacitors

C1—47-F electrolytic
C2,C3,C7—0.1-μF disc
C4,C6—4.7-μF electrolytic
C5—0.01-μF disc

Resistors (1/8-watt, 5% tolerance)

R1,R2,R3—4,700 ohms
R4—11,000 ohms
R5—15,000 ohms
R6—100,000 ohms
R7—5,000-ohm potentiometer
S9—4,700-ohm x 9 SIP

Miscellaneous

J1—DB-25 connector
J2—BNC connector
SW1,SW2—Spdt switch

For MAX180

Semiconductors

U1—MAX180, 12-bit, eight-channel A/D converter (Maxim Integrated Products)
U2—74LS541 octal buffer

Capacitors

C1—47-μF Electrolytic
C2,C4,C6,C8—0.1-μF disc
C3,C5,C7—4.7-μF electrolytic

Resistors

R1,R2—100,000-ohm potentiometer
S1,S2—4,700-ohm x 9 SIP

Miscellaneous

J1—DB-25 connector
SW1 thru SW3—Spdt Switch
SW4—Normally-closed spst switch
XTL1—1.6-MHz oscillator

that I've built and tested. To this, I'll add relevant information so that you can input 16-bit data to your computer.

Single-Channel A/D Converter

The MAX191 is a single-channel 12-bit A/D converter that can operate from a single 5-volt dc power supply or from a bipolar ±5-volt supply. It contains an internal clock and reference voltage. Thus, it requires a minimum of external parts for proper operation.

A unique feature of this chip is its ability to output serial or parallel data. You might wonder why anyone would consider serial output when parallel data transfer is so much faster. In some applications, the circuit under test may have to be isolated from the computer. (It's a lot cheaper to replace an A/D converter than a fried laptop.) With serial I/O, you have only two data lines—one in and one out. It takes only two inexpensive optical isolators to completely isolate your computer form the A/D circuitry. If your input signals have large spikes, are susceptible to static discharge or are monitoring ac inductive loads, you want to use an optically-coupled, rather than hard-wired, interface between the external circuit and your computer.

Though the interface is serial, the connection can still be made to a parallel printer port, which brings up another reason why I prefer parallel printer-port interfacing. The computer supplies the control logic and everything else is outside the computer, including independent circuits and power supplies. I get very nervous when I see data logging I/O cards inside a computer. One slide on a thick carpet, and you may be saying good-bye to all your computer's RAM! Why take chances? Use the computer to control the real world, not be zapped by it.

Shown in Fig. 1 is the complete schematic diagram for a 12-bit parallel interface data-acquisition circuit designed around the MAX191. Switch *SW1* lets you select between bipolar and unipolar operation. Switch *SW2* lets you select between a single 5-volt supply and ±5-volt supplies. You need the ±5-volt supply only if you intend to read a differential input.

The two switches are shown for clarity. For most applications, pins 2 and 8 can be hard-wired. In my prototype circuit, I shorted pins 8 and 2 to ground to configure the MAX191 for single-ended unipolar operation.

To reduce noise problems, connect ANALOG GROUND pin 7 to DIGITAL GROUND pin 12 with a short wire. Using a differential input can also reduce noise. Run a shielded twisted-pair line between the sensor and the differential input. Connect the shield of the twisted pair to the sensor's ground circuit, but do *not* connect the shield on the MAX191 side. Any noise will equally affect both twisted-pair wires and cancel.

If you reconfigure the IC for differential inputs, insert a 0.1-μF capacitor between –ANALOG IN pin 4 and ANALOG GROUND pin 7. Otherwise, connect a short wire between pins 4 and 7.

You can adjust maximum full-scale input by including the Alternate Scale adjustment insert circuit in Fig 1. The adjustment circuit lets you adjust the reference between 2.5 and 5 volts.

The MAX191 is a CMOS device, and all computer printer ports are TTL devices. Even a laptop PC advertised as a power-efficient CMOS machine uses TTL logic for its parallel printer port's output pins. The two 4050s shown as *U1* and *U2* convert the output lines of the MAX191 from CMOS to TTL logic levels. Even if the MAX191's output was TTL, I'd still include buffers between the real-world device and a computer's parallel port.

Many devices are claimed to be "TTL compatible" but are actually designed to operate only one TTL load. The printer port's low nibble bits require more power than that supplied by a low-level TTL output device. The buffers provide some inexpensive assurance that the printer port will always receive strong signals.

A few added minutes of construction time can save hours of software debugging and hardware troubleshooting. The Pull-up resistors in *S9* also help provide the computer's printer port with strong, noise-free data logic.

A conversion is started when the READ LINE to pin 19 receives a low-to-high transition signal. A conversion takes a maximum of 7.5 μs. While a conversion is in progress, the BUSY line to pin 9 is low. Therefore, during conversion, it appears as a low at pin 15 of the parallel printer port.

After a conversion, the MAX191 places the resultant binary data in its tristate output buffer. When pin 21 is set low, least-significant bits (LSB) D0 through D7 are available. When

Fig. 1. Complete schematic diagram of a MAX191 12-bit, single-channel A/D parallel printer port interface data-acquisition circuit.

Listing 1. Program Listing For MAX191

```
PROGRAM MAX191;
{
  Input 12-bit resolution data from Maxim's MAX191 12-bit A/D converter.
  Based on information in Maxim's MAX191 data sheet, 19-4506; Rev 2; 4/93
  The program operates a MAX191 hard wired for: unipolar single-ended, 0 to
  5 volt inputs, and "Parallel, Slow-Memory Mode" (page 11 & 12) for
  interfacing to the parallel printer port.

  A conversion starts when HBEN, CS, and RD lines are brought LOW.
  The MAX191's BUSY line will remain LOW during a conversion
  (maximum 7.5 uSec). A conversion is complete when the BUSY line returns
  HIGH. The LSBs, D0 to D7, can now be read from the Tri-State
  buffer. To read the MSBs, D8 to D11, bring HBEN HIGH. After reading the
  MSBs, bringing HBEN line LOW, followed by bringing the RD line
  LOW will start a new conversion. Once started, a conversion can
  not be restarted.
}

USES DOS, CRT;
CONST

Lpt_Port_Address = 888; { use 956 for MGA's port, or 632 for 3ed printer port }

(* OUTPUTS *)
     HBEN = 1; { printer port pin 2, = D0 = bit 1, of base address      }
       CS = 2; { printer port pin 3, = D1 = bit 2, of base address      }
       RD = 4; { printer port pin 4, = D2 = bit 3, of base address      }
(* INPUTS *)
     BUSY = 8; { printer port pin 15, = D3 = bit 4, of base + 1 address }
        t = 2; { delay time, varies with PC model.                       }

VAR                                        Lpt_Num : WORD;
                           New_Value, Old_Value : WORD;
                                             Volts : REAL;
     Lo_Nibble, Hi_Nibble, Lo_Byte, Hi_Byte : BYTE;


PROCEDURE Start_Conversion;
  { MAX191 will start conversion when HBEN, and RD, are brought LOW }
BEGIN { start conversion }

                                          {   D2  D1  D0   }
                                          {   RD  CS HBIN  }

Port[Lpt_Port_Address] := RD + CS;       {    1   1   0    }
Port[Lpt_Port_Address] := RD;            {    1   0   0    }
Port[Lpt_Port_Address] := 0;             {    0   0   0    }
delay(t);
END; { start conversion }

PROCEDURE Read_Data( VAR Lo_Nibble, Hi_Nibble : BYTE);
 { read Base + 2 for D0 to D3, read Base + 1 for D4 to D7 }
BEGIN { read data }
{ pull-up all Base + 2, open collector output pins, BEFORE read instruction }
PORT[Lpt_Port_Address + 2] := $04; { 00000100 since D0, 1, & 3 are inverted }
Lo_Nibble := PORT[Lpt_Port_Address + 2];
Hi_Nibble := PORT[Lpt_Port_Address + 1];
```

pin 21 of the MAX191 is set high, most-significant bits (MSB) D8 through D11 are available at pins 10, 11, 13 and 14.

The Pascal program in Listing 1 lets you input and display data form a MAX191 A/D converter. It's well-documented and should prove easy to convert to other languages, if needed.

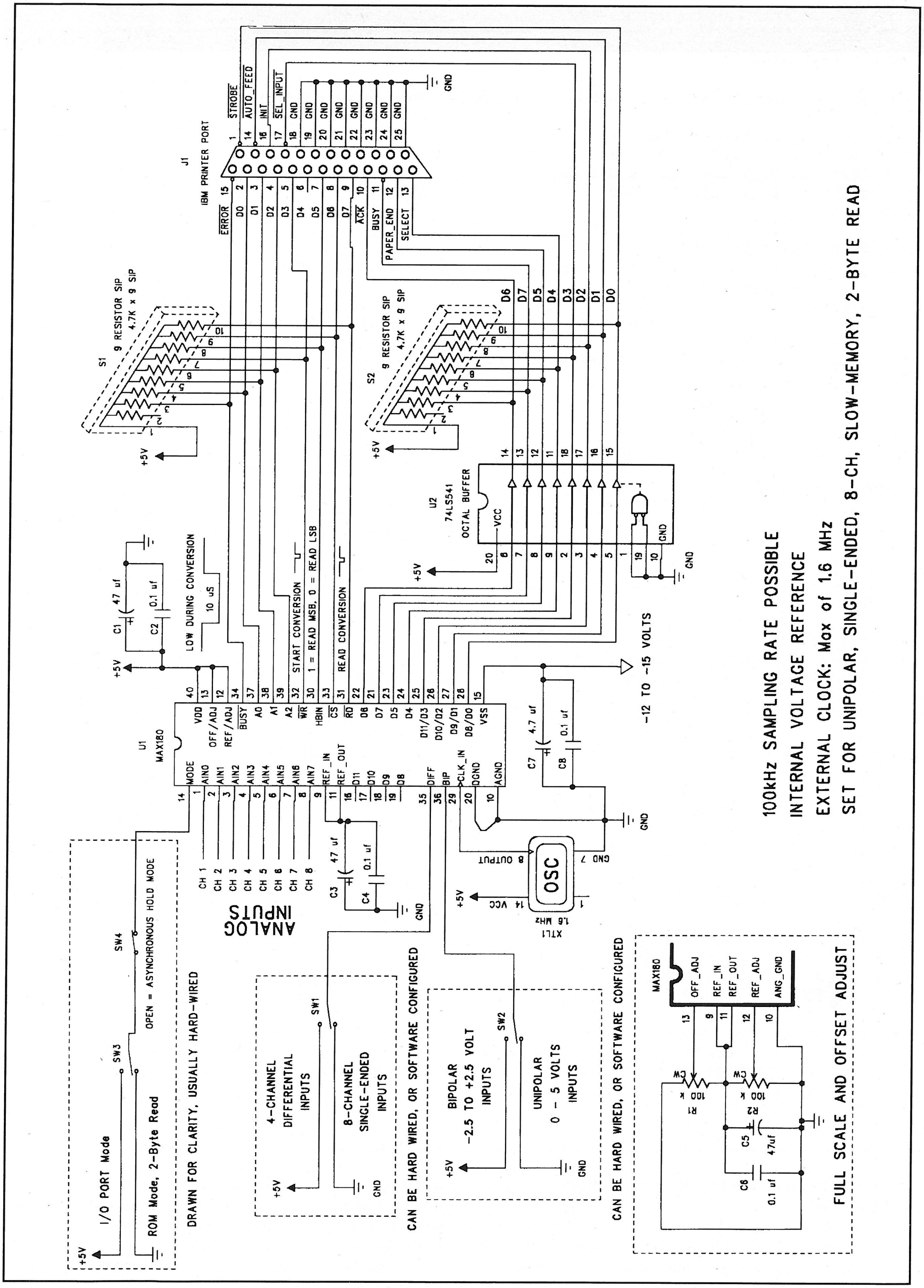
After a printer port is selected, a conversion is started by bringing the READ line to pin 19 from low to high. A conversion is completed when the BUSY line to pin 9 goes from low to high. Each data byte is read as two

```
END; { read data }

PROCEDURE Digest_Data(VAR Lo_Nibble, Hi_Nibble, Data_Byte : BYTE);
BEGIN
Lo_Nibble := Lo_Nibble AND $0F;
Hi_Nibble := Hi_Nibble AND $F0;
Data_Byte := Hi_Nibble OR Lo_Nibble;
Data_Byte := Data_Byte XOR $8B;
END; { digest data }

PROCEDURE Print_Results;
 { display the Hi_Byte, Lo_Byte, New_Value, and value in Volts }
BEGIN { print results }
GoToXY(1,10);
Writeln('Hi Byte = ',Hi_Byte:3, ';        Low Byte = ',Lo_Byte:3);
Volts := ( 5 * New_Value ) / (( 255 * 16) + 255);
Writeln; write('New_Value = ',New_Value:10,'          Volts = ',Volts:10:3);
Old_Value := New_Value;
END; { print results }

BEGIN { main, max191 }
New_Value := 0; Old_Value := 0;
ClrScr;
GoToXY(10,8); WRITELN( '-=[ MAX191 DATA ]=-' );

                                                    {   D2  D1   D0   }

                                                    {   RD  CS  HBIN  }
Port[Lpt_Port_Address] := RD + CS + HBEN;          {    1   1    1   }
  REPEAT
  Start_Conversion;
{ after exiting PROCEDURE Start_Conversion              0   0    0   }
{ did MAX191 complete a conversion? }
  REPEAT UNTIL ( PORT[Lpt_Port_Address + 1]  AND BUSY ) = BUSY;


{   D2   D1    D0      }
Read_Data(Lo_Nibble, Hi_Nibble);                   {   RD  CS  HBIN  }
{ get low byte   }
  Port[Lpt_Port_Address] := RD;                    {    1   0    0   }
  Port[Lpt_Port_Address] := RD + CS;               {    1   1    0   }
  Port[Lpt_Port_Address] := Rd + CS + HBEN;        {    1   1    1   }
  Digest_Data(Lo_Nibble, Hi_Nibble, Lo_Byte);
{ get hi byte  }
  Port[Lpt_Port_Address] := RD + HBEN;             {    1   0    1   }
  Port[Lpt_Port_Address] := HBEN;                  {    0   0    1   }
  delay(t);
  Read_Data(Lo_Nibble, Hi_Nibble);
  Digest_Data(Lo_Nibble, Hi_Nibble, Hi_Byte);
  Hi_Byte := Hi_Byte AND $0F;
  New_Value := Hi_Byte * 256 OR Lo_Byte;
{ reset control bits }
  Port[Lpt_Port_Address] := RD + HBEN;             {    1   0    1   }
  Port[Lpt_Port_Address] := RD + CS + HBEN;        {    1   1    1   }
{ only waist time going to the screen if value has changed }
  IF New_Value <> Old_Value THEN  Print_Results;
  UNTIL KEYPRESSED;
END. { main, max191  }
```

nibbles. When pin 21 is low, the eight LSB are read.

The high nibble is read from Port_Address + 1. Using a logical AND operation isolates the high nibble data from the High_Nibble data byte. The low nibble is read from Port_Address + 2. Using a logical AND operation isolates the low nibble data from the Low_Nibble data byte. A logical OR operation combines the two nibbles.

Pin 21 is then set high and the four MSB are read. The high nibble is read from Port_Address + 1. Using a logical AND operation isolates the high nib-



100kHz SAMPLING RATE POSSIBLE
INTERNAL VOLTAGE REFERENCE
EXTERNAL CLOCK: Max of 1.6 MHz
SET FOR UNIPOLAR, SINGLE-ENDED, 8-CH, SLOW-MEMORY, 2-BYTE READ
J1
IBM PRINTER PORT
S1
9 RESISTOR SIP
4.7K x 9 SIP
S2
9 RESISTOR SIP
4.7K x 9 SIP
U2
74LS541
OCTAL BUFFER
U1
MAX180
LOW DURING CONVERSION
10 uS
START CONVERSION
1 = READ MSB, 0 = READ LSB
READ CONVERSION
-12 TO -15 VOLTS
ANALOG INPUTS
OSC
XTL1
1.6 MHz
I/O PORT Mode
ROM Mode, 2-Byte Read
OPEN = ASYNCHRONOUS HOLD MODE
DRAWN FOR CLARITY, USUALLY HARD-WIRED
4-CHANNEL DIFFERENTIAL INPUTS
8-CHANNEL SINGLE-ENDED INPUTS
CAN BE HARD WIRED, OR SOFTWARE CONFIGURED
BIPOLAR -2.5 TO +2.5 VOLT INPUTS
UNIPOLAR 0 - 5 VOLTS INPUTS
CAN BE HARD WIRED, OR SOFTWARE CONFIGURED
FULL SCALE AND OFFSET ADJUST

Fig. 2. Schematic diagram for a complete eight-channel, 12-bit parallel-interface data-acquisition circuit built around a MAX180.

ble data from the High_Nibble data byte. The low nibble is read from Port_Address + 2. Using a logical AND operation isolates the low nibble data from the Low_Nibble data byte.

A logical OR operation combines the two nibbles. The results are displayed on-screen. The process is repeated until any key is pressed.

12-Bit, 8-Channel A/D Converter

Shown in Fig. 2 is the schematic diagram for a complete eight-channel, 12-bit parallel-interface data-acquisition circuit designed around a MAX-180. It operates from +5-volt and –12 to –15-volt supplies. The MAX180 requires an external oscillator operating at a maximum of 1.6 MHz.

Switch *SW1* is used to select between four-channel differential inputs and eight single-ended inputs. Switch *SW2* lets you select bipolar or unipolar operation. Switches *SW3* and *SW4* determine the type of interface used. With *SW4* open, the MAX180 uses asynchronous hold mode, which is useful when a precise or repeatable sample timing is required. With *SW4* closed, the I/O port mode or two-byte read ROM mode is selected.

Switches *SW3* and *SW4* should be combined into a single three-position switch. These switches are shown here only for clarity. For most applications, you'll probably want to hard-wire the mode configuration. In my prototype circuit, I shorted pins 14, 35 and 36 of the MAX180 to ground to configure the MAX180 for eight-channel, unipolar, slow ROM two-byte read operation.

You can omit the switches and control mode operation with software. By using software, you can mix and match inputs. Differential, single-ended, bipolar and unipolar signals can be input together. Though software control adds to the MAX180's flexibility, the circuitry gets more complicated and beyond the scope of this article. But, you should be aware of the possibilities. I'd be interested in hearing from readers who develop such a circuit.

Noise problems can be minimized by connecting ANALOG GROUND pin 10 to DIGITAL GROUND pin 20 with a short wire. Differential inputs can also reduce noise and are highly recommended.

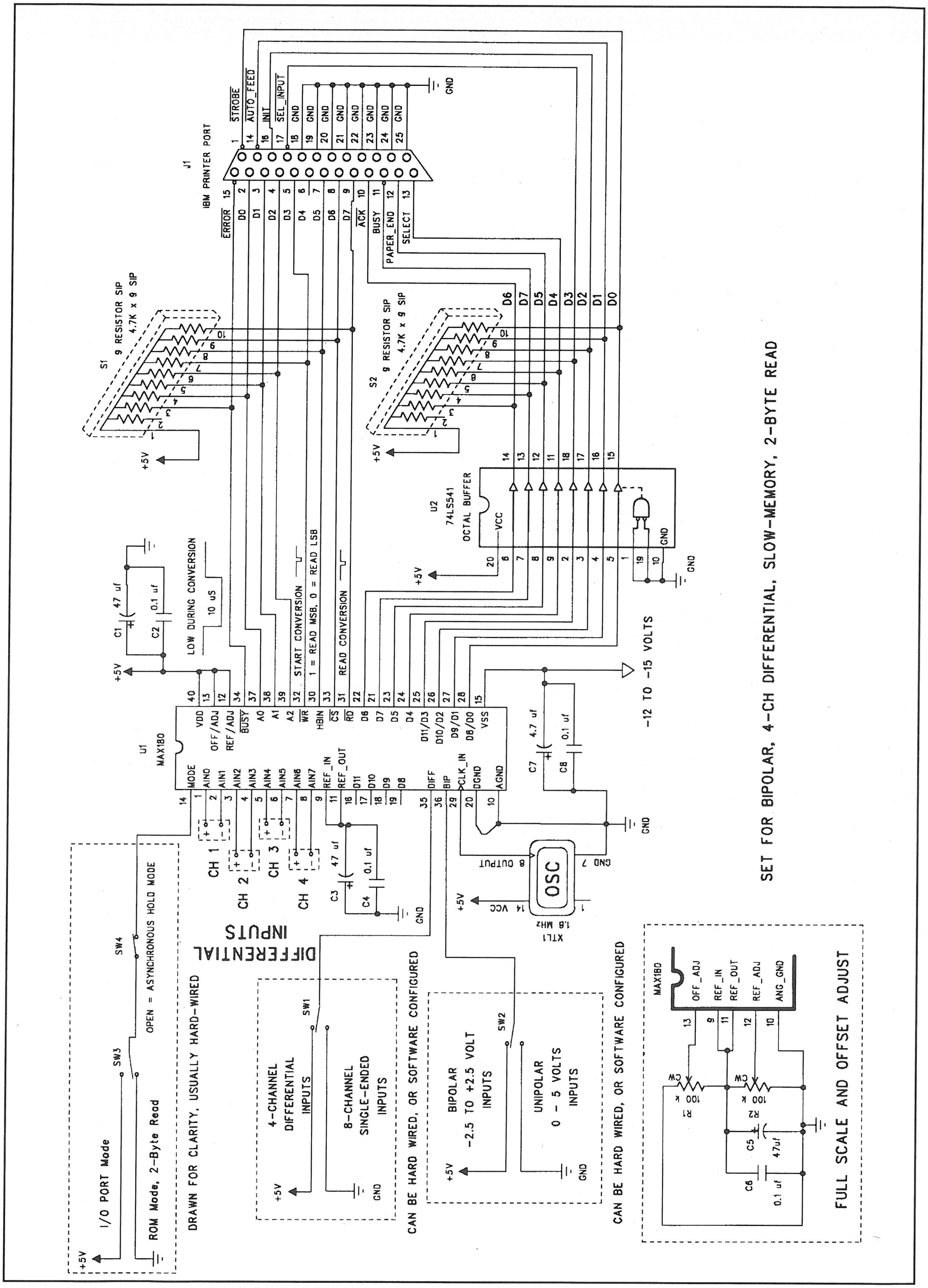
Shown in Fig. 3 is the circuitry for configuring the MAX180 for four-channel differential inputs. Use shielded twisted-pair cable between sensors and differential inputs, following the procedures described for the MAX191 above. If capacitors *C1* and *C7* are replaced by more-expensive tantalum units, you can eliminate the 0.1-µF shunting capacitors.

The MAX180 is a TTL device, as are all computer printer ports. You could interface the MAX180 directly to a printer port. However, the control logic pins at pins 1, 14, 16 and 17 require relatively strong logic signals for proper operation. The 74LS541 octal buffer and 4,700-ohm SIPs are used to ensure solid logic signals between the MAX180 and parallel printer port. Again, the parts are inexpen-

Listing 2. Program Listing For MAX180

```
PROGRAM Max180;
{
  Program to demo input of 8-channel, 12-bit, data from a Maxim MAX180
  8-channel, 12-bit, A/D converter interfaced to an IBM/compatible
  parallel printer port.

  Based on information in Maxim's, MAX180/MAX181 data sheets, 1991. Chip is
  hard wired for I/O Port Mode 1, Two Byte Read, unipolar, single ended
  inputs.

  Timing relationships are given in Maxim's Data Sheet Figure 8b, page 10.

  Written in Turbo Pascal 6.0 by Paul Bergsman 1/27/1994.  Pascal is a very
  readable programing language. Therefore, this code is easily transferable
  to other programming languages.
}
USES DOS, CRT;
CONST
 Base_Address = 888;  { use 956 for MGA's port, or 632 for 3ed printer port }
    A0 = 1;           { printer port's BASE address, data bit 1 = D0 = 1    }
    A1 = 2;           { printer port's BASE address, data bit 2 = D1 = 2    }
    A2 = 4;           { printer port's BASE address, data bit 3 = D2 = 4    }
    WR = 8;           { printer port's BASE address, data bit 4 = D3 = 8    }
  HBIN = 32;          { printer port's BASE address, data bit 6 = D5 = 32   }
    CS = 64;          { printer port's BASE address, data bit 7 = D6 = 64   }
    RD = 128;         { printer port's BASE address, data bit 8 = D7 = 128  }
  BUSY = 8; { printer port's (BASE + 1) address, the ERROR bit, = D3 = 8    }
     K = 5 / ((256 * 15) + 255);  { convert binary input to voltage         }

VAR   Data_Word : WORD;
             Ch  : INTEGER;

PROCEDURE Input_Data(VAR Channel : INTEGER; VAR Data_Word : WORD);
  { input 12-bit data from selected channel of A/D via printer port }
CONST T = 10;
VAR                              Control_Byte : BYTE;
     Lo_Nibble, Hi_Nibble, Lo_Byte, Hi_Byte : BYTE;
                                         C, E : INTEGER;

BEGIN { input data }
{       binary value                         128  64    32   8   4   2   1 }
{   -=[ INITIALIZE THE MAX180 ]=-             RD  CS  HBIN  WR  A2  A1  A0 }
{                                            --  -  ---  -  -  -  - }
Control_Byte := RD + CS + HBIN + WR + Ch; {     1   1     1   1     Ch      }
PORT[Base_Address] := Control_Byte;
Control_Byte := RD + CS + WR + Ch;        {     1   1     0   1     Ch      }
PORT[Base_Address] := Control_Byte;
Control_Byte := RD + WR + Ch;             {     1   0     0   1     Ch      }
PORT[Base_Address] := Control_Byte;

{ -=[ START CONVERSION ]=- }
Control_Byte := RD + Ch;                  {     1   0     0   0     Ch      }
PORT[Base_Address] := Control_Byte;
DELAY(t);         { t5, minimum WR pulse width = 120 ns }
Control_Byte := RD + WR + Ch;             {     1   0     0   1     Ch      }
PORT[Base_Address] := Control_Byte;
Control_Byte := RD + CS + WR + Ch;        {     1   1     0   1     Ch      }
PORT[Base_Address] := Control_Byte;

{ -=[ WAIT FOR MAX180 TO COMPLETE A CONVERSION ]=- }
Delay(t); { t9 on page 10, end WR pulse to start conversion                  }
          { MAX180's BUSY line, pin 34, will remain LOW a maximum of 160 ns  }
REPEAT                        { wait until MAX180's BUSY bit returns to HIGH }
Hi_Nibble := PORT[Base_Address + 1];
UNTIL ( Hi_Nibble AND BUSY ) = BUSY; { data is valid when BUSY returns to high }
{       binary value                         128  64    32   8   4   2   1   }
```

```
{       control logic name                          RD  CS  HBIN  WR  A2  A1  A0    }
{                                                   --  -   --    -   -   -   -  }
{ -=[ set control logic to input LSBs ]=- }
Control_Byte := RD + WR + Ch;                   {   1   0     0    1     Ch         }
PORT[Base_Address] := Control_Byte;
Control_Byte :=  WR + Ch;                       {   0   0     0    1     Ch         }
PORT[Base_Address] := Control_Byte;
delay(t);  { t16, on page 10, RD to Data Out is valid = 100 ns maximum              }

{ -=[ READ LSBs ]=- }
PORT[Base_Address + 2] := 4; { set open collector inputs high before read          }
Lo_Nibble := PORT[Base_Address + 2];
Lo_Nibble := Lo_Nibble AND $0F; { isolate LO nibble bits }
Hi_Nibble := PORT[Base_Address + 1];
Hi_Nibble := Hi_Nibble AND $F0; { isolate HI nibble bits }
Lo_Byte := Hi_Nibble OR Lo_Nibble; { combine nibbles for low data byte              }
Lo_Byte := Lo_Byte XOR 139; { Invert inverted hardware wired inputs 10001011       }

{ -=[ set control logic to input MSBs ]=- }
Control_Byte :=  RD + WR + Ch;                  {   1   0     0    1     Ch         }
PORT[Base_Address] := Control_Byte;
Control_Byte :=  RD + CS + WR + Ch;             {   1   1     0    1     Ch         }
PORT[Base_Address] := Control_Byte;
Control_Byte :=  RD + CS + HBIN + WR + Ch;      {   1   1     1    1     Ch         }
PORT[Base_Address] := Control_Byte;
DELAY(t); { t11, page 10, RD high pulse width, 200 ns maximum                       }

Control_Byte := RD + HBIN + WR + Ch;            {   1   0     1    1     Ch         }
PORT[Base_Address] := Control_Byte;
Control_Byte :=  HBIN + WR +  Ch;               {   0   0     1    1     Ch         }
PORT[Base_Address] := Control_Byte;
delay(t);  { t16, page 10, RD to Data Out is valid = 100 ns maximum  }

{ -=[ INPUT high 4 bits ]=- }
PORT[Base_Address + 2] := 4;    { set open collector inputs high before read   }
Lo_Nibble := PORT[Base_Address + 2];
Lo_Nibble := Lo_Nibble AND $0F;     { isolate LO nibble bits                        }
Hi_Nibble := PORT[Base_Address + 1];
Hi_Nibble := Hi_Nibble AND $F0;     { isolate HI nibble bits, 0 for 12-bit A/D  }
Hi_Byte := Hi_Nibble OR Lo_Nibble; { combine nibbles for high data byte           }

Data_Word :=  (Hi_Byte * 256) + Lo_Byte;

Control_Byte :=  RD + HBIN + WR + Ch;           {   1   0     1    1     Ch      }
PORT[Base_Address] := Control_Byte;
Control_Byte :=  RD + CS + HBIN + WR + Ch;      {   1   1     1    1     Ch      }
PORT[Base_Address] := Control_Byte;
DELAY(t);
END; { input data }

BEGIN { max180 }
ClrScr;
GOTOXY(1,2);
WRITE('CHANNEL      VALUE');
  REPEAT
  GoToXY(1,4);
  FOR Ch := 0 to 7 DO    { use 0 to 3 for 4-Ch, differential inputs }
    BEGIN { for channel }
    Input_Data(Ch, Data_Word);
    IF KEYPRESSED THEN EXIT;
    WRITELN(Ch:4,'       ',(Data_Word):10, ' raw data');
    WRITELN(Ch:4,'       ',(Data_Word * k):7:3, ' volts');
    WRITELN;
    END; { for channel }
  UNTIL KEYPRESSED;
END. { max180 }
```



J1
IBM PRINTER PORT
U1
MAX180
U2
74LS541
OCTAL BUFFER
S1
9 RESISTOR SIP
4.7K x 9 SIP
S2
9 RESISTOR SIP
4.7K x 9 SIP
LOW DURING CONVERSION
10 uS
START CONVERSION
1 = READ MSB, 0 = READ LSB
READ CONVERSION
-12 TO -15 VOLTS
OSC
XTL1
1.8 MHz
DIFFERENTIAL INPUTS
I/O PORT Mode
ROM Mode, 2-Byte Read
OPEN = ASYNCHRONOUS HOLD MODE
DRAWN FOR CLARITY, USUALLY HARD-WIRED
4-CHANNEL DIFFERENTIAL INPUTS
8-CHANNEL SINGLE-ENDED INPUTS
CAN BE HARD WIRED, OR SOFTWARE CONFIGURED
BIPOLAR -2.5 TO +2.5 VOLT INPUTS
UNIPOLAR 0 - 5 VOLTS INPUTS
CAN BE HARD WIRED, OR SOFTWARE CONFIGURED
SET FOR BIPOLAR, 4-CH DIFFERENTIAL, SLOW-MEMORY, 2-BYTE READ
FULL SCALE AND OFFSET ADJUST

Fig. 3. Circuitry for configuring MAX180 for four-channel differential inputs.

sive and take very little time to solder. As before, a little extra effort now can save hours of software debugging and hardware troubleshooting later on.

The inset at the lower-left in Fig. 3 shows the additional circuitry needed to obtain full-scale and offset adjustment.

A conversion is started when the WRITE line to pin 32 gets a low-to-high transition signal. A conversion takes a maximum of 10 µs. While a conversion is in progress, the BUSY line to pin 34 remains low. Therefore, during conversion, the BUSY signal appears as a low at pin 15 of the parallel printer port.

After a conversion, the MAX180 places the resultant binary data in its tristate output buffer. When pin 30 is brought low, the eight LSB on D0 through D7 are available. When pin 30 of the MAX180 is brought high, the four MSB on D8 through D11 are available at pins 28, 27, 26 and 25.

Listing 2 illustrates how to read eight single-ended unipolar inputs from a MAX180 via a parallel printer port. Though the software inputs 12-bit data, the same algorithms can be employed to input 16-bit data. The Pascal program listing is heavily documented. The remarks relate to information in Maxim's MAX180 data sheet, 19-3950, Rev. 0:6/91.

At the end of the program is the main control loop. The main programming loop is repeated eight times, once for each channel. During each loop, the program calls procedure INPUT_DATA to input a voltage reading from the MAX180 and then displays the data on-screen. The process is repeated until you press any keyboard key.

The INPUT_DATA procedure initializes the MAX180 to accept instructions and then starts a conversion by bringing low and then high the WR line to pin 32. Next, the program polls pin 15 at Base_Address + 1 until it returns to high, indicating the end of a conversion. The program then inputs the 12 data bits as two bytes (MSB and LSB). The two bytes are combined into one word of data for display.

Lastly, the main program loop displays the data on-screen and repeats the steps with the next analog channel. The main loop is repeated until any keyboard key is pressed.

Summing Up

In this article, I've shown you how to build a single-channel MAX191 and an eight-channel MAX180 A/D converter. I've presented basic circuits that I've built and tested. However, the MAX191 and MAX180 can make many more conversions per second than my software can read. The included material will be adequate for most readers. To fully exploit the power of these chips, though, several of the Pascal procedures will have to be rewritten in assembly language. If you write such code, send me a copy and I'll try to publish it in a future article. I also encourage you to write to me with comments and suggestions for future topics. ■

By Hardin Brothers

Plug and Play

Soon to be the answer to your hardware-installation woes

It's time to install a new network, video system, CD-ROM drive, image scanner, SCSI card or modem card. Anyone who has been around PCs for a few years can predict exactly what will occur at this point. You open the package, read the instructions and hope that the default settings on the card will work for your computer. You open your computer's system unit, plug the card into an open expansion-bus slot and nothing—nothing at all—happens. You remove the card and re-boot, and everything's fine. So you figure that the card's settings have to be changed.

You try moving some jumpers and changing some switch positions and test the card again. After a few attempts, the computer boots normally with the card installed. But then you discover that the new card doesn't work nor do your mouse and printer. So, once again, you fiddle with switches and jumpers and driver settings in your CONFIG.SYS file, with MSD or whatever diagnostic programs you can find, until you get everything working in harmony. If it took you only four hours to install a new sound card, you're proud of yourself for being so efficient.

If you've done the peripheral shuffle, you deserve a pat on the back for being knowledgeable enough to try it at all. Many computer users always call the repair shop when they want to install a new card, while others simply dump one computer and buy another instead of ever installing a new peripheral.

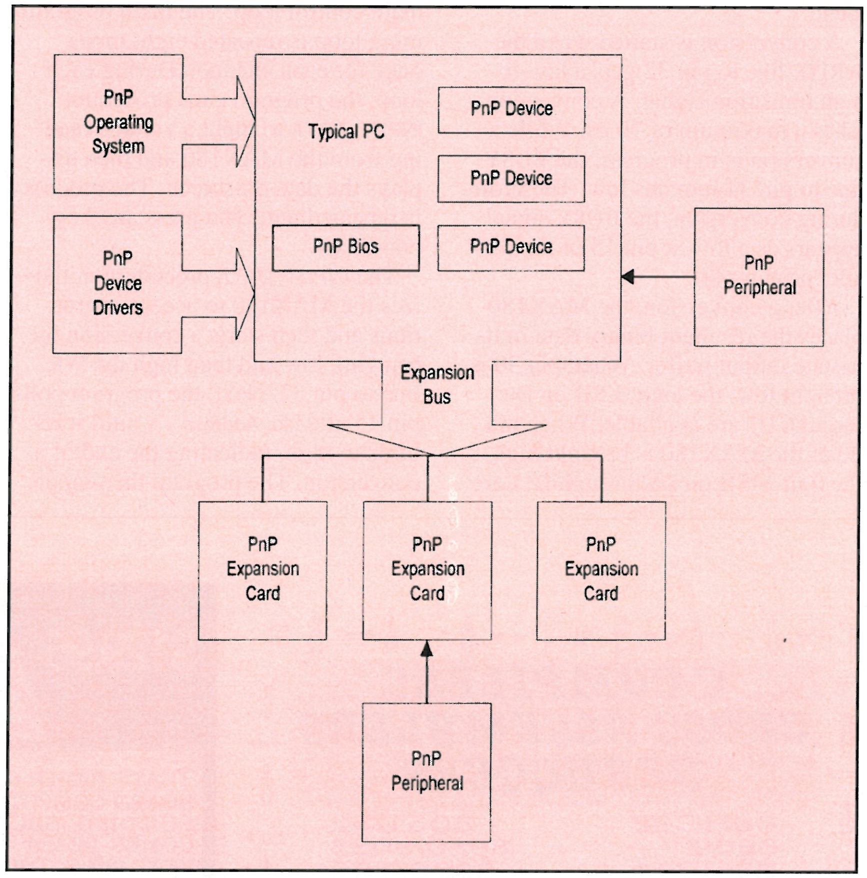


Fig. 1. Block diagram of typical Plug and Play system.

Never Again!

All of the hassles of installing new peripherals and accessories in a PC should quickly fade into a bad memory of the past if an industry consortium, led by Microsoft, has its way. Instead of setting jumpers and switches or worrying about IRQs and DMA channels, users should be able to install new cards about as quickly as they can slide a new CD-ROM into a drive. As a bonus, their computers will be able to re-configure themselves automatically when they change PCMCIA cards, dock or undock a notebook computer at a docking station or make other changes while the computer is running.

The technologies behind this advance are lumped together under the term "Plug and Play," or PnP for short. The ideal of this group of technologies is that the computer can configure itself and any accessories, resolve resource conflicts and get the most out of each card and add-on product. The whole process will be automatic, fast and almost fool-proof.

In addition, you'll be able to enable or disable any accessory at any time, change your system configuration with the computer running and create a list of all hardware and accessories, complete with brand name and model number, performance characteristics and resources used by each piece.

Of course, doing all of this is no easy task. It requires cooperation between computer manufacturers, BIOS

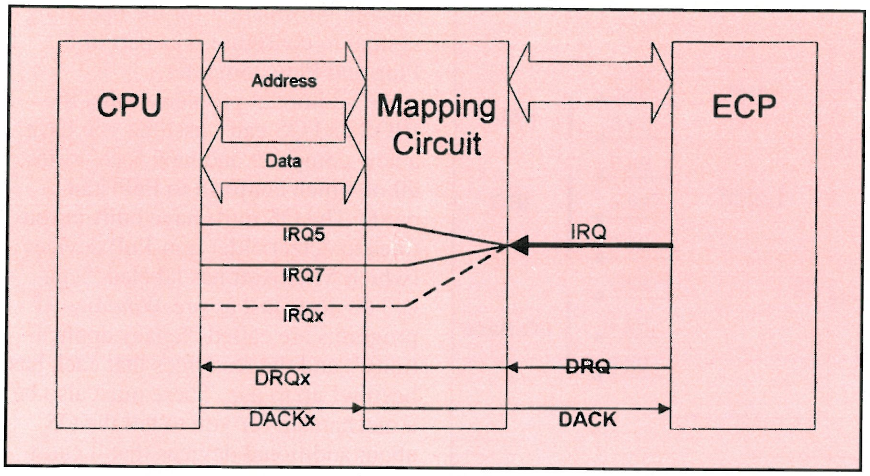


Fig. 2. Details of Plug and Play ECP parallel port.

writers, peripherals manufacturers, device-driver programmers and, perhaps most importantly, operating-system vendors. With so many companies and such a variety of them involved, there are bound to be glitches that might be more difficult to fix on a Plug and Play computer than they were a few months ago on an "old-fashioned" 486 or Pentium AT-compatible computer.

Putting It Together

Plug and Play demands three things: flexible components and peripherals, a way to allocate resources and resolve conflicts and an operating system or driver software that hides the details of resource allocation from application software. For example, a CD-ROM drive card might meet the requirements by having eight or more possible configurations. The BIOS might be able to select the configuration that will work best during boot-up, and the driver software should be able to hide details of ports, I/O addresses, DMA channels, etc., from application programs that use the CD-ROM drive.

When you boot a Plug and Play computer, it examines itself to make sure you haven't installed a new boot-up peripheral card while it was turned off. Then it configures itself to make all of the necessary boot-up components work in harmony. Finally, once the operating system starts, the computer and its BIOS present a list of internal hardware devices and how each is configured.

The operating system then configures the entire system, including devices that weren't enabled during boot-up. Applications that run on top of the operating system shouldn't have to concern themselves with devices or resources at all. They should be able to simply request hardware services from the operating system and let it decide how to communicate with the particular hardware you've installed in your computer on a particular day.

Someday, this ideal will be a common reality. But so far, because of incompatibilities in hardware, BIOSes, operating systems and computer peripherals, it seems to be about 50% promise and 50% actuality. If you understand how it's all supposed to happen, it's easier to work through those occasions when a system refuses to follow the formula.

The first requirement of Plug and Play is that everything in a system, from its buses and motherboard components to its printers and modems, be detectable. For example, both the BIOS and the operating system should be able to determine whether your computer uses an AT, PCI or VL bus (or some combination of the three) and what kind of bridges are used between the buses in the computer. Also, both should be able to determine such things as how many IDE hard-disk controllers are installed in your computer and what's attached to each.

The second requirement is that almost everything, from built-in hardware to new expansion cards, be configurable through software. It does little good to have, say, an SCSI card that can be configured a dozen different ways if you have to select among the different configurations and set one with switches and jumpers. The computer should be able to take care of all of this itself.

Finally, Plug and Play depends on cooperation of the BIOS and operating system. A non-PnP BIOS or a non-PnP operating system like DOS 6.2 or *Windows* 3.1 knows nothing of the possibilities of PnP devices. To take full advantage of Plug and Play, you need a computer with a PnP BIOS, a PnP motherboard, PnP expansion cards and a PnP operating system.

To date, the only OS that supports PnP is *Windows 95*. Other operating systems—like *Windows NT*, OS/2 and some of the PC-based versions of Unix—will likely support PnP in their next major revisions.

At Boot-Up

In a true Plug and Play system, you can install a new expansion card by simply plugging it into an empty bus slot on your computer's motherboard, starting your computer and telling the operating system to activate the new card. The mystery is how the computer and software do the work that used to take you hours of head scratching to accomplish in the pre-Plug and Play era.

For example, suppose your computer has an ECP (extended capabilities port) you use as a parallel port for your printer. At a minimum in a PnP computer, the ECP should be able to be attached to IRQ5 or IRQ7, I/O addresses at 3BCh, 378h or 278h and DMA Channel 0 or 3. That is, it should be addressable as LPT1, LPT2 or LPT3. A more-flexible ECP would be able to use any IRQ, an address port and any DIRQ/DACK pairs for direct data transfers.

While it's highly unlikely your ECP would be so completely flexible, in a PnP system, it could easily use seven IRQs plus "disable IRQ," seven sets of I/O addresses plus "disable port" and at least three DMA channels plus "disable DMA." By selecting among the possible sets of capabilities, the computer might configure this ECP as LPT1 (I/O at 3BCh, IRQ7, DMA1), LPT2 (378h, IRQ5, DMA3) or any of several non-standard configurations.

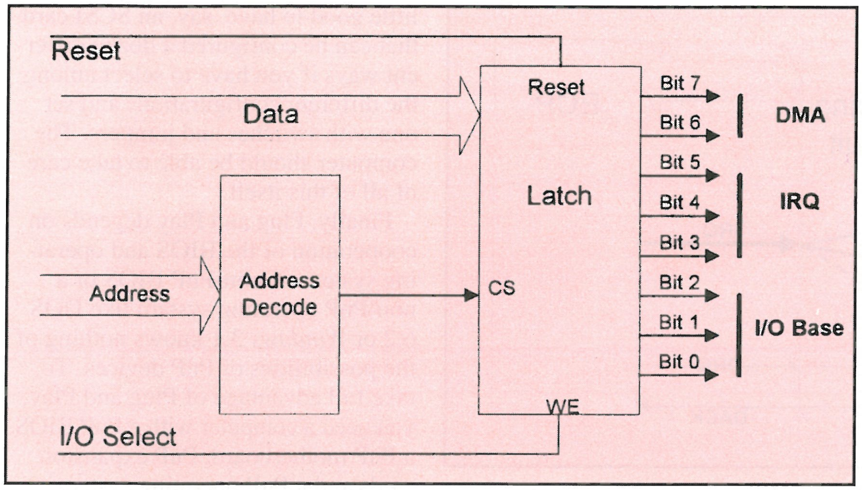


Fig. 3. Typical mapping circuit control.

If your computer has four such ports, older non-PnP programs and operating systems might be able to use two of the ports as LPT1 and LPT2. A PnP-capable operating system and programs written for it would be able to use all four ports. But this still doesn't explain how either the BIOS or an operating system sets up the port. To do this, the computer uses a mapping circuit between the ECP or other component and the CPU.

The mapping circuit connects the port's IRQ, DRQ and DACK signals to the correct control, address and data lines (see Fig. 1 and Fig. 2). In our simple example, the mapping circuit could be controlled by a single eight-bit latch, as shown in Fig. 2.

Of course, the mapping latch would have to be at a known address in this example. On most motherboards, it would occupy a single I/O address in the reserved range of 00h to 0FFh, which is the range of addresses reserved for static devices. Similar mapping circuits or an entire mapping engine would be used to give more flexibility to other motherboard devices, such as the auxiliary time, DMA controller, serial ports, etc.

Figures 1 and 2 are merely logical diagrams. On an actual Plug and Play motherboard, all of the details would likely be hidden away inside an ASIC (applications-specific integrated circuit) or other specialized IC.

To control the boot-up process, the BIOS must know how to configure components on the motherboard, as well as boot-up accessories connected to expansion cards (such as drive controllers, video adapters, etc.). Some of the configuration can be done by using default addresses hard-coded into the BIOS itself and some can be done using values stored in CMOS memory.

Many Plug and Play computers are shipped with a configuration program that must be run from a bootable floppy disk (to avoid conflicts with TSRs and other drivers) that helps users install new hardware if they aren't going to run *Windows 95* or another PnP OS.

Start the OS

Once a PnP Operating System takes over the computer, it's in charge of everything. It receives a list of installed motherboard devices (including buses and bridges) from the BIOS and is responsible for configuring and re-configuring the entire computer. It must have this flexibility to avoid as many resource conflicts as possible. I'm certain that some day we'll be reading studies about how a given PnP OS does the best job of detecting and resolving IRQ, DMA, I/O address and other resource conflicts.

The OS has a difficult task. It must isolate each device, determine its resource needs and capabilities and then configure each element of the system. It receives information about each device in the form of a number, which it matches against a list of known devices and their capabilities. At minimum, then, each new device must be shipped with a disk file that contains enough information for the operating system to configure it as part of a Plug and Play computer.

An additional problem is that the BIOS and OS can't assume you have a new computer and new accessories, all of which conform to PnP standards. The OS must have built-in routines to detect older non-PnP devices (which Microsoft has labeled "legacy" devices, just as pre-*Windows 95* programs are called "legacy applications") and the resources that each has been set up to use. There must also be a mechanism for you to tell the OS about additional devices that it can't recognize, including, perhaps, such things as one-of-a-kind control or data-acquisition cards.

As the first PnP OS, *Windows 95* provides a framework that other operating systems will probably follow as they implement Plug and Play in their upcoming versions. During initialization, *Win95* follows a specific routine to properly configure and initialize the computer:

- *Windows 95* identifies each device, reads its resource requirements and loads its drivers.
- Next, it allocates resources to each device and reallocates resources when devices request identical resources.
- If any change is made to the system configuration, *Windows 95* repeats the first two steps. The entire process is managed centrally, in *Windows 95*, to ensure coordination of all devices and resources.
- Configuration information is shared between the hardware, BIOS and operating system.

During the first step, *Windows 95* builds and then later refines an internal database of devices. The database typically takes the form of a tree, which *Windows 95* displays when you select the Device Manager tab from System Properties, which appears when you right-click My Computer and select Properties from the menu. Figure 4 shows a small portion of the Device Manager display for an actual Plug and Play PC.

Detecting and identifying devices on a local (PCI or VL), a Micro Channel or EISA bus or in a PCMCIA slot isn't too difficult because each of these includes control lines that help the computer communicate with individual cards. But the ISA or AT bus, which is present either alone or in

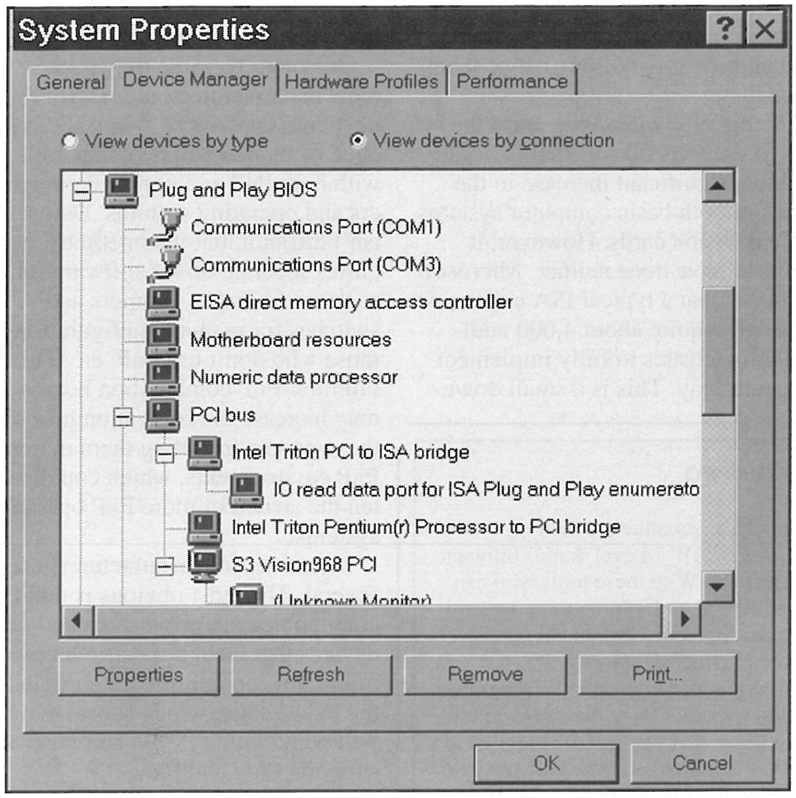


Fig. 4. Small portion of Device Manager display for an actual Plug and Play PC.

conjunction with a local bus in most desktop computers, provides a real challenge. Since all bus lines go to every ISA slot, the operating system can't just poll one card at a time.

The operating system and Plug and Play expansion cards on an ISA bus communicate through a set of three eight-bit ports. Two of these ports, fixed at addresses 0279h and 0A79h, are write-only and are the same as the default Printer Status Port and Printer Status Port + 800h. The third port, which is read-only, can be relocated in the range of 0203h to 03FFh to avoid conflicts with legacy expansion devices.

The operating system begins by asserting the RESET DRV signal on the ISA bus to reset all expansion cards. Next, it sends an initialization string of 32 specific bytes to one of the write-only ports. Then each card enters an "Isolation" mode that permits the operating system to work with one card at a time. The secret to this isolation is a unique nine-byte value stored on each card. The number is made up of a four-byte manufacturer code, a four-byte product code and a one-byte checksum. No two cards in the system are permitted to have the same eight-byte code number and one-byte checksum.

The system reads the identification numbers one bit at a time and, with the help of the cards themselves, manages to isolate each one. It does so by reading the first bit from all cards.

Any card with a 1 in the current position drives the data bus to 55h. Cards with a 0 in this position place their data bus driver in a high-impedance state and then check whether any card is sending a 55h value.

The software reads the same bit again. This time, cards that were sending a 55h invert it to 0AAh, and the cards that had set a high-impedance state leave their bus driver unchanged. Again, the cards in high-impedance state look to see if any other cards are sending 0AAh. If so, they drop out of the polling until the next iteration.

The software repeats the polling for 72 bits (144 reads in all) and lets cards drop out as they see others with a 1 bit where they have a 0. By the end of this process, one card remains, which the operating system can work with individually. It can read the

card's resource data, put the card in its hardware tree and make a preliminary resource assignment to the card. The operating system then starts the process again, finding the next card on the bus, until no PnP expansion cards remain.

Bottom Line

The whole effect of Plug and Play seems like magic to those of us who have struggled with expansion cards and scarce resources for years. The above descriptions, which are necessarily simplified and limited in scope, explain how some of this magic takes place.

The big fear when Plug and Play was first discussed was that it would lead to a significant increase in the prices of both basic computer systems and expansion cards. However, it seems to have done neither. Microsoft estimates that a typical ISA expansion card will require about 4,000 additional logic gates to fully implement Plug and Play. This is a small downside in these days of high-density ASICs and other specialized chips.

One other possible drawback is that most manufacturers, at least for the next couple of years, will want to produce cards that will be compatible with both PnP and non-PnP computers and operating systems. Doing so isn't difficult, but it sometimes requires separate driver software for each environment, jumpers and switches for manual configuration for those who don't use PnP, etc. The PnP/non-PnP combination boards may increase the frustration levels of those people installing them in non-PnP environments, which could hasten the arrival of more PnP operating systems.

Incentives for manufacturers are several. The most obvious is that PnP-compatible expansion cards and other devices that meet a specific level of minimum capabilities are eligible for the PC 95 logo, which shows that they will work with a PC 95 computer that supports Plug and Play.

More important to most companies, however, is that PnP devices will typically require much less support than earlier cards and peripherals. Generally, software drivers for PnP devices are simpler and easier to write than those for legacy devices. Also, most companies expect many fewer technical-support telephone calls and faxes because users won't have to hassle with jumpers, switches and interactions between multiple expansion cards.

Finally, PnP will give users more control over their computers as they discover that they can turn on and off some expansion devices, plug and unplug PCMCIA cards and dock or undock notebook computers without going through a re-boot cycle. You'll only have to tell your PnP operating system that you've changed the system configuration, and it should update the hardware tree and card configurations. A few seconds later, you'll be working with a completely different computer.

Some industry pundits keep saying that computers are really appliances and that they should be as easy to use as toasters. With Plug and Play, adding and removing hardware devices is just about as easy as sliding a slice of bread into the toaster or pulling one out and covering it with butter and jam. ■

Bits 'n' Pieces **By Alexander W. Burawa**

Having made the switch, you're probably hunting high and low for 32-bit applications that can take advantage of the new 32-bit *Windows 95* operating environment. Not that many apps besides mainstream business ones specifically written to run under *Win95* are available yet. TommySoftware *CAD/DRAW* 4 Level 1 from Germany is an exception and, given its low price, expandability and ease of use, it's an exceptional buy for *Windows 95* and *Windows NT* 3.51.

TommySoftware states that *CAD/DRAW* 4 Level 1 is "a full-fledged graphics application that combines the advantages of powerful illustration packages with the precision of CAD products without their complicated interfaces." Having worked with it for a few hours, I can attest to the accuracy of this description. Thanks to an almost intuitive user interface and on-line tutorial, both previous CAD users and newcomers to CAD work should be able to quickly come up to speed.

This program is rich in features, among which are an on-line guide that takes the place of a hard-copy user's manual. This manual offers lots of hand-holding to guide you through every step of a project and tells you at any given moment what options are available.

The program is a 2D and 2½D rendering tool, which you can upgrade to full 3D capability by adding a module that was in the works at this writing. Other modules make the program expandable in other directions to enhance and increase the functionality of *CAD/DRAW* 4.

One of CAD/DRAW 4's more-appealing features is its smart libraries that let you to change a symbol in one library and have the change take effect in all drawings in which it appears. This can be a real time saver in updating designs. Each library can store up to 1-million symbols. A nested structure, symbol cache and hierarchical structure are built in.

CAD/DRAW 4 Level 1 adds bitmaps and erasers. With these tools, you can combine true-color bitmaps and vector graphics into one file and cut out selected areas using the eraser.

Another nice feature is the program's ability to output large drawings on multiple pages that you can tile together to make a complete project. This obviates the need for a large-format printer or plotter.

You can insert comments into drawings for sharing your documents with workgroups. Included are a full-featured text editor, *TrueType* and *PostScript* font support and the ability for you to design your own font sets. In addition, *CAD/DRAW* 4 Level 1 features improved Drag and Drop functionality. It reads *AutoCAD* files.

I've sampled the on-line tutorial and conclude that it's more than adequate for training a user to working with *CAD/DRAW* 4 Level 1. After a few hours "doodling" with the program, just to see what its capabilities are, I'm satisfied it's more than a good rendering package for yeoman service. I readily recommend it to anyone who can't afford or justify the cost of a $500 and up CAD package.

To use *CAD/DRAW* 4 Level 1, you need at least a 386 PC with 8M of RAM, *Windows 95* or *Windows NT* 3.51, 10M of free hard-disk space, a mouse, VGA graphics and, for the CD-ROM version, a CD-ROM drive. Though the program will run on a minimum system, I recommend at least a 486 PC or, better still, a Pentium 100, either with 16M of RAM to make it fly.

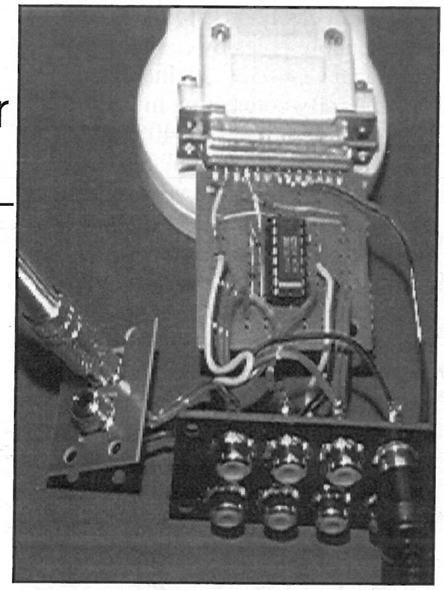
You can purchase TommySoft *CAD/DRAW* 4 Level 1 on CD-ROM or floppy disk. You can also test it before you buy by downloading it via the Internet from any major on-line service at http:// www.tommysoftware.com.

(Continued on page 79)

By Ramon A. De La Cuetara

Build a Programmable Dual Four-Position Switch

A PC controls this super-simple switch controls up to four audio, video or other low-voltage/low-current sources



With the rapidly increasing availability of multimedia products, the dividing line between home-entertainment systems and personal computers has all but disappeared. Nowadays, the number of cables, connections and signals in a typical setup is so great that there are many times when you'd like to use a computer to switch between several audio and video signals. Though a device like this would certainly be a boon to many of us, reasonably priced devices to perform this function are all but nonexistent. Fortunately, technology exists that lets you build such a switching device at very low cost. In this article, I'll describe a circuit that plugs directly into the serial port of your PC and is simple to program and use. With it, you can switch as many audio, video and other low-voltage/low-current sources as you wish.

About The Circuit

The circuit mentioned above is a computer-controlled two-pole, four-position Switch based on the CD4052 CMOS IC, as shown in Fig. 1. Two digital signals are used to select the switch position. These are the serial port's Request to Send (RTS) and Transmit Data (TD) lines. The serial port also provides the power to the IC, through the Data Terminal Ready (DTR) and RTS lines. A diode bridge made up of *D1* through *D4* rectifies the two signals, which are always kept at opposite voltages, which is required because RTS doubles as a control line. The resulting voltage is about ± 8 to ± 9 volts, for a total of about 16 to 18 volts, which is within the maximum rating for devices of the CD40XX family.

This is a true switch, either side of which can be used for output or input, and for positive or negative voltages

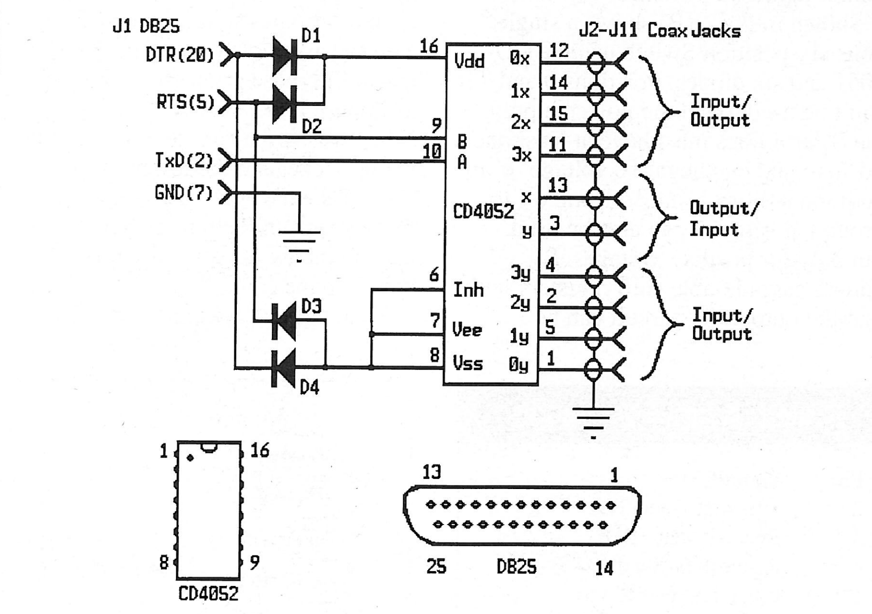
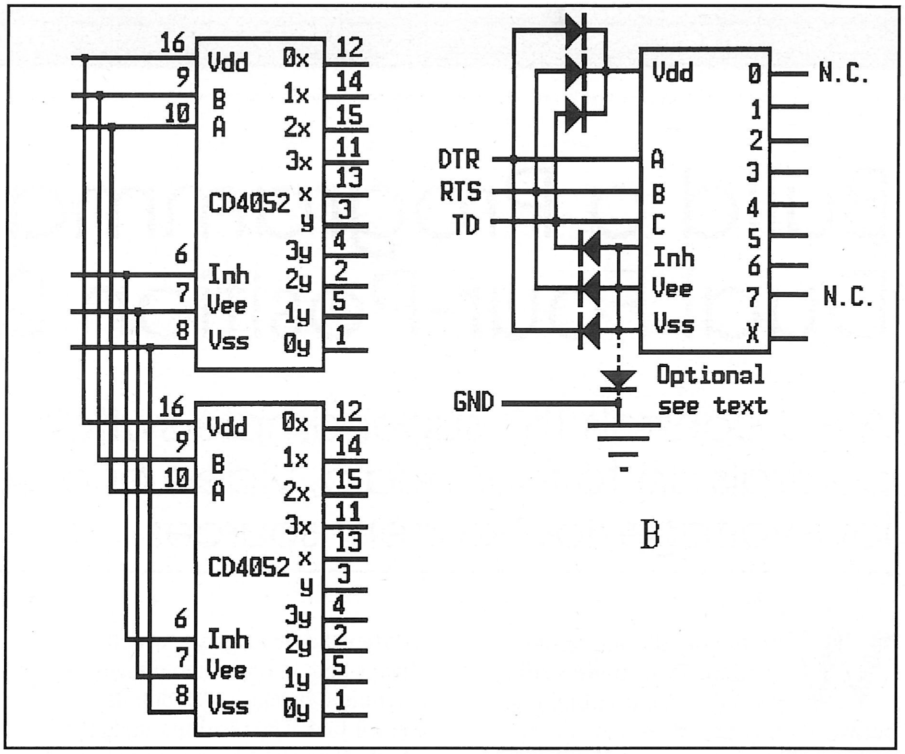


Fig. 1. Schematic for the switch circuit.

Parts List

D1 thru D4—Any silicon rectifier or signal diode (1N4002, 1N4148, 1N914, etc.)
CD4052—Dual 4:1 CMOS analog switch.
J1—DB-25 female D-shell connector
J2 thru J11—Coaxial jack
Misc.—16-pin DIP IC socket; copper-clad breadboard (Radio Shack Cat. No. 276-159A or similar); about 3" x 2" enclosure; machine hardware; hookup wire; solder; etc.

Fig. 2. Modification required to get (A) four poles and (B) one pole six positions.



within the limits of the power supply. Switch "on" resistance is about 80 ohms, and "off" leakage current is in the picoampere range. Bandwidth goes from dc to about 30 MHz. These characteristics make the Switch suitable for many small signal applications, such as video or audio signals.

You can easily modify the Switch to provide more poles by connecting additional CD4052s, as illustrated in Fig. 2(A). By connecting in parallel all 16 pins of additional CD4052s, it's possible to get lower "on" resistance. CMOS devices require very little power, and the serial port can handle dozens of them at a time.

Other CD40XX family devices can be substituted to obtain different combinations of poles and positions. Some candidates for such modifications are illustrated in Fig. 3. The CD4016 and CD- 4066 have four separate spst switches. The CD4016 has great "on" resistance and a narrower bandwidth than the CD4066. The CD4053 has three spdt switches, and the CD4051 is a single-pole, eight-position switch. The CD4051/2/3 chips also have an inhibit input (all switches "off").

Shown in Fig. 2(B) shows a single-pole, six-position Switch using a CD-4051 and six diodes. Positions 0 and 7 can't be used to get the power supply the control lines must have at least one positive and one negative voltage. If an additional diode is added from Vss to ground, position 7 can also be used, but only for positive voltages. By adding cascade-able shift registers with parallel output, the circuit can be extended to any number of poles and positions.

Construction

All components for building the switching the circuit can be purchased at a local electronics store for about $15. You can assemble the circuit using any general-purpose printed-circuit board and house it in a suitable enclosure. When wiring the circuit, begin by solder the IC socket and diodes into place. Then place the board between the two rows of pins of the female DB-25 connector and use hookup wire jumpers to wire it to the connector.

To aid you in wiring the circuit, there's a drawing of the 25-pin DB-25 connector, with pin numbers called out, at the lower-right in Fig. 1. Also shown, at the lower-left is the pin-numbering scheme for the IC.

Select a convenient location on the enclosure for the two common coaxial jacks and eight switched jacks. Drill appropriate-size holes for all jacks. If the jacks install from the outside, mount them in their respective holes on the enclosure first. Then connect the center terminal of each to the corresponding circuit-board position with short lengths of insulated hookup wire. The common jacks connect to the X and Y pins of the CD4052, the switched jacks to the 0X through 3X and 0Y through 3Y pins.

Table 1. Serial-Port Signals*

Pin	Signal
2	Transmit Data (TD)
3	Receive Data (RD)
4	Request To Send (RTS)
5	Clear To Send (CTS)
6	Data Set Ready (DSR)
7	Signal Ground (GND)
8	Carrier Detect (CD)
20	Data Terminal Ready (DTR)
22	Ring Indicate (RI)

*DB-25 connector.

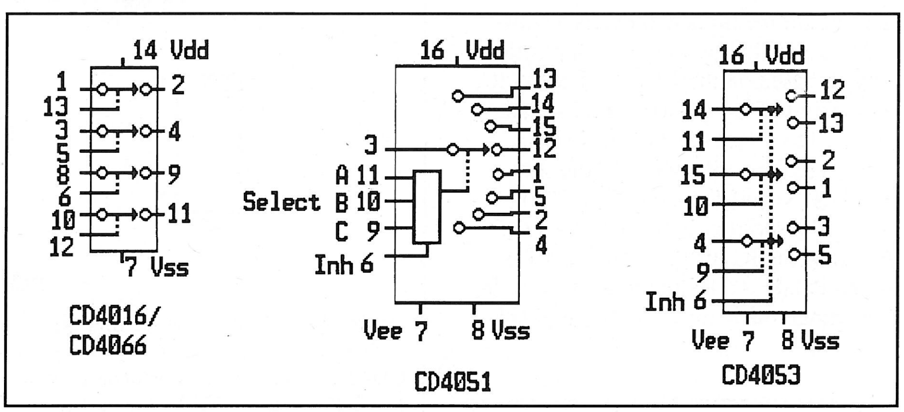


Fig. 3. CMOS family switch ICs.

Table 2. Serial-Port Registers

Address	Register
Base+0	Transmitter Holding (Out)
Base+0	Receiver Buffer (In)
Base+0	Divisor Latch, Low Byte* (Out/In)
Base+1	Divisor Latch, High Byte* (Out/In)
Base+1	Interrupt Enable (Out/In)
Base+2	Interrupt Poll (In)
Base+3	Line Control (Out/In)
Base+4	Modem Control (Out/In)
Base+5	Line Status (In)
Base+6	Modem Status (In)
Base+7	Scratch Register (Out/In)

*Accessible when Bit 7 of Line Control Register is set to 1.

Table 3. Serial-Port Base Addresses

Port	Base Address
COM1	3F8h
COM2	2F8h
COM3	3E8h
COM4	2E8h

Table 4. Bit Assignment for Selected Serial Port Registers

		Registers	
Bit	Line Control	Modem Control	Modem Status
7	Div. Latch Access	Reserved	CD Status
6	Set Break* (TD)	Reserved	RI Status
5	Stick Parity	Reserved	DSR Status
4	Parity Even	Loopback	CTS Status
3	Parity Enable	Out 2	Delta CD
2	Stop Bits	Out 1	Trailing RI
1	Data Length 1	RTS*	Delta DSR
0	Data Length 0	DTR*	Delta CTS

*Bits used by Switch Circuit.

The 0X pin is Switch position 1, the 1X pin is position 2, and so on.

Form a daisy chain joining all the outer terminals of the jacks and connect it to the ground pin from the DB-25 connector. When you're done, your project should look like the prototype shown in the lead photo. After double-checking all connections and testing the power supply (see below), plug the CD4052 into the socket, making sure that no pins overhang the socket or fold under between IC and socket, and assemble the enclosure. (Note: Be careful when handling static-sensitive CMOS devices. Grounding yourself with a wrist strap is a good idea.)

Programming

Connect the Switch to the computer through an RS-232 serial port. Although intended for serial data communication with peripheral devices, the

Bits 'n' Pieces By Alexander W. Burawa

(from page 74)

Going this route, you have 30 days to decide if you want to buy it.

On the CD-ROM is the Tommy-Software Direct magazine if you're interested in learning about Level 2 of the program. Since *CAD/DRAW* originated in Germany, both English and German versions are on the CD-ROM as well.

CAD/DRAW 4 Level 1, $79.95 (CD-ROM); $29.95 (Extra for Floppy Disks); $59.95 (Qualified Upgrade)
TommySoftware North America, Inc.
130 Barrow St., #516
New York, NY 10014
Tel.: 2120807-9720; fax: 1-212-807-8149; CompuServe: 100020,3647
CIRCLE NO. 131 ON FREE INFORMATION CARD

Cool Screen Saver

Nowadays, you can find all sorts of screen savers for your PC. One of the best I've seen in a long time is the *National Audubon Society Wild Birds Screen Saver* from BOCA*Soft*. This multimedia package comes with a quick-reference manual (an oversize sheet of paper printed on both sides and folded to about the dimensions of a CD-ROM sleeve) that details how to install the program on a PC under both *Windows* 3.1 and *Windows 95* and how to use it.

Installation takes just a few minutes, at completion of which, the program restarts *Windows* for the changes to take effect. Once this is done, double-clicking on the screen-saver icon brings up its Main screen, which is the first page in a steno-type pad. Here, you choose the screen-saver image you want to use from a list of nine. Four are animated with bird flybys. The remainder are static, with sets of pictures and text displayed one after another or with bird calls and, optionally, identifier captions.

The four animated savers are titled Boreal Habitat (a winter scene with snow-capped mountain in the background and my favorite), Lake habitat, Seaside Habitat and Wetlands Habitat. Each sets a specific theme, with the background static and only the birds animated. In each of these Habitats, you can select one, two or three types of birds and the number of birds ranging from a few to a horde for flyby. Furthermore, you can select the speed of flyby from slow to frantic. A slide control is provided for erasing the backgrounds after a preset time (to prevent burn-in) for each of these Habitats.

The non-animated screen savers from which you can choose include: About Audubon, Bird Calls, Bird Quiz, Bird Watch and Sanctuaries.

About Audubon provides a running commentary on the National Audubon Society, with photos and associated captions displayed one after the other in a user-selected preset time sequence. Bird calls presents a blank screen, to which you can optionally add caption identifiers for the bird calls you hear. Bird Quiz flashes a picture of a bird and a question with two or more answers from which you make a mental choice. The next screen provides the correct answer. The process then repeats with another question-and-answer screen pair. Bird Watch flashes a variety of bird photos, each with its identifier caption at the bottom. Finally, Sanctuaries (there's only one in the basic program) flashes on-screen a series of photos and associated captions about various areas in a given bird sanctuary.

Though you can select one of the nine possible screen savers as the only one active, you can also select any two or more to alternate with each other at intervals you can set yourself and in a variety of order sequences. The main screen also provides a volume control and Help and Test buttons.

(Continued on page 94)

port can be used for other purposes. It has three output and five input lines, which are detailed in Table 1. All but one of these, the receive data (RD) line, are directly accessible from programs and can be used for interfacing circuits compatible with the voltage levels defined by the RS-232 standard. The standard specifies that between +5 and +15 volts defines a "1" and between -5 and -15 volts defines a 0. The port can also be used to power circuits since the output lines can handle a few milliamperes at about ±8 volts. Devices and circuits in which power supply regulation isn't critical such as the CD40XX family of logic devices, and operational amplifiers are good candidates.

I have used serial ports to power circuits using two TL084 quad operational amplifiers—eight operational amplifiers in all—with good results. A word of warning: there's a recent standard, compatible with RS-232 for communication purposes, intended for use in laptop and notebook PCs that operate on lower voltages and less current. I've yet to see one of these, but it's possible that the circuit won't work properly with them.

The port uses an 8250 or equivalent UART which is programmed through 11 registers (Table 2) using eight consecutive I/O addresses, starting with the base address of the port. Table 3 lists the base addresses of PC serial ports. Three registers are used to access the external lines of the port. Bit assignments for these are listed in Table 4.

You need only two registers for controlling the Switch: the line control register at base+3 to program the TD line and the modem control register at base+4 to program RTS and DTR. For COM1 the respective addresses are 3FBh (1019 decimal) and 3FCh (1020 decimal). Table 5 lists the required I/O instructions, and Listing 1 has BASIC and turbo-Pascal programs for controlling the Switch. You can include the subroutine in line 1000 of the BASIC program and procedure SetSwitch of the Pascal program in your own programs to control the Switch.

Since the sub-programs don't check for validity of the position value, the calling program should verify that the value is in the range of 1 to 4. In BASIC assign the position you want to variable POSITION and then use GOSUB 1000, in Pascal use SetSwitch(n);, where *n* is an integer constant, variable or expression.

Listing 2 is a TSR program that can be used to control the Switch using "hot keys" while running most DOS application programs. Unfortunately, it doesn't work under *Windows*. The program select a Switch position when any of the Alt+1 through Alt+4 key combinations is pressed. Since many programs also use these key combinations, the TSR includes an escape code (Alt+5) to pass the keystroke to the program instead of setting the Switch. For example, if you want to use Alt+1 in a program while the TSR is in memory, press Alt+5 followed by Alt+1. The TSR moves the address of the keyboard interrupt (INT9) routine to INT63h, one of the interrupts reserved for user programs, and replaces the address with its own.

When a key is pressed or released, an INT9 will be generated, the TSR will immediately issue an INT63h instruction, letting the computer handle the interrupt as it normally does. However, when the service routine is done, it will return to the TSR instead of the original program. The TSR will then use INT16h to check the keyboard buffer and take one of the following actions: if no input is ready or the input isn't one of the "hot keys," it returns to the original program; if the escape code (Alt+5) has been pressed, it resets a flag and returns; if the input is Alt+1 through Alt+4, it sets the Switch and removes the input from the keyboard buffer before returning; or if the input is Alt+5, it sets a flag, removes the input and returns.

Table 5. Output Instructions Required for Switch Selection

Switch Position	RTS	RD	Output To Base+3	Output To Base+4	Example In BASIC,COM1=3F8h
1	0	0	0	1	OUT &H3FB,0:OUT &H3FC,1
2	0	1	64 (40h)	1	OUT &H3FB,64:OUT &H3FC,1
3	1	0	0	2	OUT &H3FB,0:OUT &H3FC,2
4	1	1	64 (40h)	2	OUT &H3FB,64:OUT &H3FC,2

Listing 1. BASIC and Turbo Pascal Programs

BASIC Program

```
10 POSITION=1 : GOSUB 1000
20 INPUT "Select the switch position (1-4), or 0 to exit ";POSITION
30 IF POSITION < 0 OR POSITION > 4 THEN GOTO 20
40 IF POSITION=0 THEN STOP
50 GOSUB 1000
60 GOTO 20
1000 IF POSITION > 2 THEN OUT &H3FC,2 ELSE OUT &H3FC,1
1010 IF (POSITION MOD 2) = 0 THEN OUT &H3FB,64 ELSE OUT &H3FB,0
1020 RETURN
```

Pascal Program

```
Program Switch;
var Position:byte;

procedure SetSwitch(P:byte);
begin
if P > 2 then port[$3FC]:=2 else port[$3FC]:=1;
if (P mod 2) = 0 then port[$3FB]:=64 else port[$3FB]:=0;
end;

begin
SetSwitch(1);
repeat
repeat
write ('Select the switch position (1 - 4) or 0 to exit ');
readln (Position)
until Position in [0..4];
if Position <> 0 then SetSwitch(Position);
until Position=0;
end.
```

Listing 2. TSR Program

```
;**** Analog Switch TSR driver ****
switch segment para
assume cs:switch,ds:switch
resident proc far
org 0100h
flag:    jmp start                  ;flag storage and initial entry
entry:   int 63h                    ;TSR entry: let bios handle the interrupt
         push ax                    ;save callers ax on return from bios
         mov  ah,1                  ;check for keyboard input
         int 16h
         jz  exit                   ;nothing to do if no input
         test byte ptr cs:flag,1    ;test low bit of flag, ignore this input?
         jnz exit1                  ;yes, go reset flag
         or al,al                   ;special code?
         jnz exit                   ;no, ignore the input
         cmp ah,120                 ;is it alt 1 through alt-5?
         jb exit                    ;not if below 120
         cmp ah,124
         ja exit                    ;or above 124, ignore those keys
         mov ah,0
         int 16h                    ;yes it is, remove it from the buffer
         cmp ah,124                 ;is it alt-5?
         je exit1                   ;if yes then go set the ignore flag
         push dx                    ;if not then save caller's dx before we
         mov dx,3fbh                ;set the switch. you must change 3fbh here
         xor al,al                  ;to the serial port address, if it's not COM1
         out (dx),al                ;assume td is going to be 0
         shr ah,1
         jnc ok1                    ;if assumed right go set rts
         mov al,64                  ; else set td to 1
         out (dx),al
ok1:     mov al,1                   ;assume rts=0, dtr=1
         inc dx
         out (dx),al
         shr ah,1
         jnc done                   ;if assumed ok we're done
         inc al                     ; else set rts=1, dtr=0
         out (dx),al
done:    pop dx                     ;recover caller's dx
         jmp exit                   ;and we're done
exit1:   inc byte ptr cs:flag       ;toggle low bit of flag
exit:    pop ax                     ;recover caller's ax and
         iret                       ;return from interrupt
;end of resident portion, initialization code starts here
start:   mov      ax,3509h          ;get the address of int 09h service routine
         int      21h               ;to check if we're already resident
         mov      ax, es:[bx]       ;look at the first instruction
         cmp      ax,63cdh          ;is it an int 63h instruction?
         je       oops              ;yes, program is already resident, go exit
         mov      dx,bx             ;otherwise
         mov      ax,es
         mov      ds,ax
         mov      ax,2563h          ;copy address for int 09h to int 63h
         int      21h
         mov      dx,offset entry   ;and hook int 09h
         mov      ax,cs
         mov      ds,ax
         mov      ax,2509h
         int      21h
         mov      dx,3fch           ;initialize the port, you must change 3fch
         mov      al,1              ;here to the correct value for another port
         out      (dx),al           ;only rts & dtr initialized, td defaults to 0
         mov      dx,offset start   ;terminate and stay resident
         int      27h
oops     mov      ax,4c01h          ;exit program without staying resident
         int 21h                    ;with error code set to 1, handy for batch
resident endp
switch ends
end  fla
```

The program can be assembled with TASM or MASM and then converted to a .COM file with EXE2BIN. If you lack assembly-language experience, you use the BASIC program given in Listing 3 to create the .COM file. The programs use COM1 and should be modified for a different port in the places indicated in the listings.

Checkout and Use

Without the CD4052 plugged in the socket, connect the Switch to your PC with a standard serial cable. Run either of the programs in Listing 1, using the base address for your serial port. The programs initially select position 1 of the Switch. Use a dc voltmeter or a multimeter set to the dc-volts function to measure the voltages between pins 16 (+) and 8 (ground) of the socket. You should obtain a reading in excess of +15 volts.

Cycling the program through all four positions as you measure, your meter reading shouldn't change more than a few tenths of a volt. If this test fails, power down and look for a bad diode or loose connections.

When everything checks out, disconnect the circuit, plug the CD4052 into the socket and connect it again. Once again, check the power supply. It should provide a reading of about the same as before. If you obtain a reading of a few volts, you've plugged the IC into the socket backwards. Having done just this when I first assembled the circuit, it shows one advantage of the limited current output of the serial port. After several minutes, I realized my error, corrected the problem and everything worked fine. A regular power supply would have "cooked the IC" within seconds.

Cycle the Switch trough all four positions while measuring the resistance from the common pin to each of the four position pins of each pole. The selected position should provide a reading of about 80 ohms, and the other three should appear to be open (infinite resistance). Also check the DTR, RTS and TD signals against the levels listed in Table 4 (DTR should be the opposite of RTS), a 0 is negative voltage, a 1 positive voltage. If the test fails, check the wiring. If it's okay, the CD4052 is defective.

If everything checks out, assemble the enclosure and label the coaxial jacks. The Switch is ready for use.

You can connect to the Switch and control practically any signal that's within the power supply voltages and has a bandwidth of up to 30 MHz. I've tried every video/audio source I could get my hands on without noticing any loss, among them, several VCR's, a videodisc player, a CD-I player, a VGA-to-NTSC converter, and a couple of video cameras.

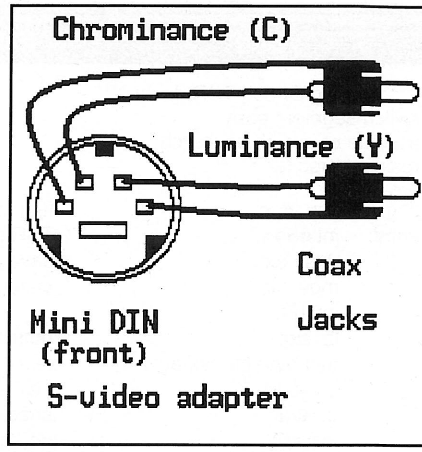


Fig. 4. S-video adapter for switch.

If your serial cable is very long and you observe noise, adding a 0.1-F capacitor from V_{DD} to V_{SS} will correct the problem.

You can use this Switch for S-video. To do so, you'll have to make a mini-DIN-to-coaxial adapter, using the details given in Fig. 4. The S-video signal consists of two separate signals, chrominance and luminance. Thus both poles will be required. By adding a second CD4052, as illustrated in Fig. 2, you can also switch stereo sound.

With some experimentation, you'll find many applications for the circuit, including programmable mixers, filters, amplifiers, motor control circuits, sample and hold circuits, etc. ■

Listing 3. BASIC Program to Generate TSR

```
5 REM BASIC program to generate .COM TSR switch driver
10 OPEN "SWITCH.COM" FOR OUTPUT AS #1
20 FOR I = 1 TO 129
30 READ A1: A$ = CHR$(A1): PRINT #1, A$;
40 NEXT I
50 CLOSE #1
60 STOP
1010 DATA 235,75,205,99,80,180,1,205,22,116
1020 DATA 64,46,246,6,0,1,1,117,51,10
1030 DATA 192,117,52,128,252,120,114,47,128,252
1040 DATA 124,119,42,180,0,205,22,128,252,124
1050 DATA 116,28,82,186
1053 DATA 251,3:REM for COM2 use 251,2 for COM3 235,3 and for COM4 235,2
1057 DATA 50,192,238,208
1060 DATA 236,115,3,176,64,238,176,1,66,238
1070 DATA 208,236,115,3,254,192,238,90,235,5
1080 DATA 46,254,6,0,1,88,207,184,9,53
1090 DATA 205,33,38,139,7,61,205,99,116,34
1100 DATA 139,211,140,192,142,216,184,99,37,205
1110 DATA 33,186,2,1,140,200,142,216,184,9
1120 DATA 37,205,33,186
1123 DATA 252,3:REM for COM2 use 252,2 for COM3 236,3 and for COM4 236,2
1130 DATA 176,1,238,186,77,1,205,39,184,1,76,205,33
```

By Ted Needleman

Microcomputer Musings

Running in Place

As usual, I've been playing with some neat stuff. First off, Fargo followed up with the FotoMUG! set it promised when it shipped me the FotoFUN! printer I reviewed last time. In case you missed it, FotoFUN! Is a $400 thermal dye-sublimation printer that creates great looking 4" × 6" prints of digitized photographs and other graphics. Fargo promises lots of great accessories for FotoFUN!, like postcard paper, bumper stickers and the previously mentioned mug kit. As production is just now really ramping up, the mug kit is the only product (other than the standard 4" × 6" "photo" paper) I've received.

The kit is pretty simple. For $30, you get four white mugs, a special mug clamp, a roll of masking tape and a set of instructions. The mugs are treated on the outside surface with a special coating.

To make a personalized mug, you first create a print on the FotoFUN! printer. This is pretty much a click-and-go operation, but there are two differences between a print created for transfer and one to put in your photo album.

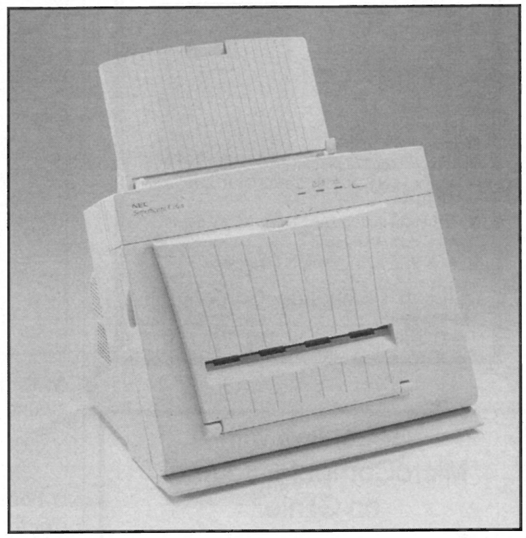
Fargo's FotoFUN! printer driver has two settings that must be changed for a transfer print. The first de-selects printing of a clear panel that's normally printed after the yellow, magenta and cyan panels are put down. This transparent panel print protects the finished print, but it interferes with the transfer process. You should also select a second box, labeled MIRROR, that flips the print horizontally so that when the transfer takes place, the result is facing in the same direction as the original photo or graphic.

Put in a piece of the 4" × 6" paper and then print. When printing is done, creating a custom mug is just a matter of taping the print to the mug with the included masking tape. The somewhat sparse directions that instruct you to be careful in positioning provide a valid caution because it's easy to skew the photo or make it too loose, which results in a blurry transfer. At $7.50 a try, you can't afford too many mistakes.

When you're satisfied that the photo is correctly positioned and taped, you clamp the supplied metal band around the mug/photo combination and place it in an oven preheated to 425°. You could probably use a toaster oven for this, but at $7.50 a mug, I wasn't about to experiment.

After 15 minutes, you remove the mug from the oven (with a pot holder or padded mitts, of course, being that the mug is very hot at this point) and place it in a bowl of warm water to drop the temperature to a level where you can remove the metal clamp and peel off the photo and tape. If everything works right, you have a terrific-looking photo mug, just like the ones that cost twice as much in your local shopping mall.

My kids are all clamoring for their own mugs, and I can see that friends and relatives will be putting their requests in when they see the results that will soon be filling my cabinets. Fargo notes that it will be offering refill kits of four or a dozen mugs without the clamp. Hopefully, the per-mug cost will come down a bit.



NEC's ColorScript 3000 offers a low-cost entry into wax-transfer and dye-sublimation printer with a PC/compatible or Mac computer for about $1,000.

I'm also following up on a few tips I've received for other sources of coated mugs. I'll pass along any that pan out. But even at the $10-per-mug cost this first kit works out to (I screwed up the first mug), I have to admit that it's pretty cool to be able to point to a photo mug and brag that I turned it out myself. I haven't had this much fun with a printer since I turned out all of those custom tee-shirts with the Fargo Primera printer and a couple of packages of heat-transfer paper.

In the NEC of Time

Fargo's Primera and Primera Pro printers were ahead of their time, offering both thermal wax-transfer and dye-sublimation options for less than $1,500. The problem with leading the pack is that if you're heading in the right direction, there's usually someone coming up right behind you nipping at your heels.

Star Micronics took a shot at this market last year with its $1,000 WinType 800c wax-transfer printer. But it couldn't offer the high-quality dye-sublimation output that made the Fargo printer such an amazing buy. With the SuperScript 3000 Color Printer, NEC has stepped up to bat and hit a home run on the first pitch.

NEC is already well-know for its high-end PostScript color and laser printers. SuperScript 3000 is a whole different breed of color printer for NEC. It follows in the footsteps of Star and Fargo in offloading the heavy-duty rasterizing process to the PC (or in the case of the NEC printer, to a Macintosh as an option).

With its LCS-3210 speaker systems, Labtec carves a new niche in better-quality PC sound and, at about $120 for the stereo pair, even offers surround-sound emulation.

For the PC market, SuperScript 3000 is strictly a *Windows*-based printer. It offers no DOS printer emulation, and it won't work with DOS applications, even in a DOS window. In this respect, it's similar to both the Fargo and Star printers, which also require *Windows*. There are a number of very important differences between the NEC and these other printers as well.

The first major difference is that while the NEC printer is priced at $1,000, which is the same level as the Star and about $500 less than the Fargo Primera Pro, unlike the Star printer it's also a dye-sublimation unit in addition to providing lower-cost thermal wax-transfer capabilities. As with the Fargo printer, which also offers both thermal-wax and dye-sub capabilities, the NEC printer's 300-dpi resolution wax-transfer mode is fairly inexpensive. Churning out prints runs between 50 and 75 cents per page, depending on the type of ribbon (three- or four-color) used and whether or not you buy NEC's super-smooth thermal transfer paper or use your own plain paper.

Dye-sublimation printing offers almost photographic output, but it requires a special ribbon and special paper. Depending on quantity purchased, this NEC mode will cost a bit shy of $3 a page, which is pretty much in line with, or even somewhat less than, other dye-sub printers.

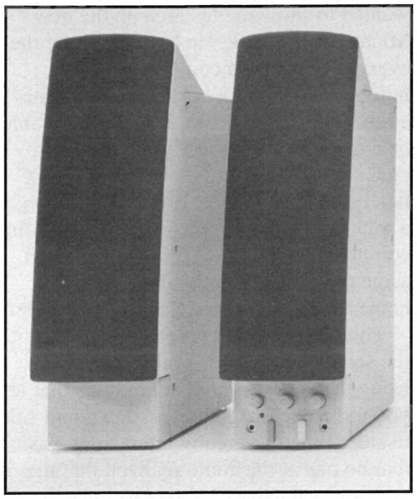
ColorScript 3000 doesn't stop here. Going beyond the Primera, NEC offers a third mode it calls "Graphic Color." This mode requires a ribbon and paper set different than either of the other two modes and is actually a wax-transfer mode that permits the size of the dots to be varied. This technique is somewhat similar to the resolution-enhancement approach used in many laser printers. Depending on the particular material being printed, it can offer a very large increase in apparent resolution of the print.

Dye-sublimation printing also uses a variable dot size, but it enhances the output further by varying the dot density or amount of dye that's actually deposited in a particular spot. In turn, this changes the apparent color intensity. Cost for the "Graphic Color" mode is in the middle of the other two printer modes, though it's a bit closer to wax-transfer than dye-sub.

Setting up the NEC printer was a five-minute job, much of which was spent installing the printer driver. NEC's driver is worth separate mention. The ColorScript 3000 is a *Windows* Printing System-compatible printer. This means that the printer is capable of bidirectional communication with *Windows*, assuming you have a bidirectional printer port (most newer PCs do). This permits the printer to continuously report the status of the print job. NEC's driver displays an animated panel to keep you apprised of the progress.

I've seen similar driver capabilities with a number of other printer drivers, most notably in color inkjet printers, and I really like them. NEC could take a page from Lexmark, however. Lexmark's WinWriter 150c color inkjet driver has a visual representation of the ink cartridges with approximate level of ink remaining. A similar display of the remaining ribbon would be a very helpful addition to NEC's already excellent software driver.

Color inkjet printers still make a lot more economic sense for many home users. But if you need to produce really good-looking color output for your small business or home office, NEC's ColorScript 3000 gives a lot of output choices at a very reasonable price.



Presenter TView from TView offers high-quality conversion of a PC's output for display on an ordinary or S-Video TV receiver for about $450.

Can You Hear Me?

It seems like I've been doing more than a few speaker reviews lately. First there were the Yamaha YST-10s and Yamaha subwoofer. Then Bose sent a pair of multimedia speakers. Now there's a set of Labtec LCS-3210s sitting next to my PC in my home office. I've gotta level with you, though. About the only real qualifications I have to review speakers is a pair of ears, and given the noise level in my house with my hoard of kids, even these don't always work too well.

While I certainly won't claim to be an audiophile, I generally can tell the difference between a $10 set of speakers and a set in the $100 range. While fabulously successful, Labtec has generally produced speakers that are closer to the less-expensive level. More often than not, when you open almost any vendor's multimedia upgrade kit that includes speakers, you'll find Labtec units. While Labtec's line has been successful, it hasn't garnered much in the way of critical acclaim.

The LCS-3210 series aims to do something about Labtec's reputation as a strictly low-end (though high-volume) purveyor of multimedia speakers. For one thing, at an expected street price of about $120 a pair, these aren't inexpensive speakers. In fact, while they're considerably less expensive than the Bose speakers I reviewed, they're a bit more expensive than the Yamaha speakers that used to occupy the place of honor on my home office system.

Not only are the LCS-3210s priced like no other Labtec speakers that have come before them, they also look and sound much different. First off, each speaker unit is a thin, tall item that's meant to stand next your video monitor and take up very little room on your desk. With heavy cases of molded cream-colored resin and a crisp gray faceplate, these speakers look classy. And with a two-way design that marries a 3 1/4" high-excursion woofer and a 5/8" dome tweeter to each other in each transmission-line case, they sound good, too.

You still can't obtain really gut-wrenching bass sound from a pair of desktop speakers. So you'll have to add a subwoofer if you want to really annoy the people who live downstairs. Even with this caveat, though, to my ear, the new Labtec speakers sound as good as the Yamaha YST-10s I had. The speakers are amplified and deliver 20 watts of rms power, which is enough to have my wife yelling at me to turn them down when I play Apogee's *Rise of the Triad*.

Game playing is a really major reason to buy these particular speakers because built into them is Spatializer 3D stereo sound. This effect is controllable from a push switch on the speaker's main panel. When activated, it really does provide an amazing effect.

Lots of software programs have directional information coded into them, and the result is that you really hear things in

different directions, even way off to your side. This gives a new edge to game playing. It's surprising how quickly you start relying on aural clues when you can determine not only that there's an "enemy" lurking ahead, but that he's on the left side of the doorway you have to go through.

I still don't have much time for games. But when I do play one of the first-person shooters, Labtec's LCS-3210 speakers really add to my enjoyment. If you're not a game player, Labtec makes the model LCS-3010 that comes without the Spatializer circuitry and sells for about $90. I like the Labtec LCS-3210 speakers a lot. They provide really good sound, and the Spatializer 3D effect really adds something to the games I play.

See Me, Feel Me

I probably spend too much time giving presentations. It often seems that if I'm not giving a presentation, I have a vendor in my office giving one to me. Usually, when a vendor calls to arrange a demo of his product, he asks if I can provide a large-screen VGA video monitor to which he can connect his laptop computer. My answer is most often no! Even if I have an extra monitor available, the last thing I feel like doing is lugging it around my office for a 15-minute demo.

In the past, I've used scan converters, devices that convert the output from a PC so that it can be displayed on the screen of a standard TV receiver. But even fairly expensive units have invariably proved to be generally unsatisfactory. Because TV receivers frequently have considerably less than 500 lines of vertical resolution, they can display a standard VGA image only with a degree of difficulty. The most-frequent problems are large portions of the screen that aren't visible, ripping or tearing of the picture as sync slips and a great deal of flicker.

I recently had a nice surprise, though, with the new Presenter TView from Tview. TView is the newest addition to the Presenter Series line of products. I've reviewed earlier products from Tview, including the Presenter Plus and the company's Electronic Marker. At that time, the company was called Consumer Technology Northwest. With introduction of the newest unit, the company changed its name to Tview, which is also the name of the product.

As with previous versions, TView ships with software for both the PC and Mac platforms. The software includes Tview's Electronic Marker that allows you to "write" on any *Windows* screen and another disk that's really only optimized screen fonts. All scan conversion is carried out in hardware. The unit also comes with cables to connect to the video output ports of either a PC or a Mac. The video monitor, if used, then plugs into the TView.

Plug in the power cube, and run either the S-Video cable (if your TV receiver has an S-Video input) or the standard composite phono-plug cable to your TV receiver, and you're in business. You can install the *Windows* or Mac screen fonts, but I usually don't bother.

I recently had a visit from a vendor who wanted to show me his area on the new Microsoft Network. He brought along the ever-present laptop computer. Since a number of people in my office also wanted to sit in on the demo, I thought it would be a good time to give TView a try. Unpacking it and setting it up with the NEC notebook PC my guest brought took about a minute. The 19" Sony TV receiver in my company's conference room is the exact same unit I have in my family room at home and doesn't feature an S-Video input.

There was a small amount of the top of the screen that wasn't visible, even after using the unit's front panel buttons that let you move the image up and down and side to side. What was really interesting was that no one at the demo realized that the unit was a standard TV receiver and not a big AV monitor. There was no flicker at all, and the slight tearing in horizontal red lines that's common with this type of product (and, for that matter, with many large-screen AV monitors as well) was minimal.

TView isn't inexpensive, with a suggested retail price of $449. Lots of mail-order outlets and superstores will have it available for considerably less cost. If you make a lot of presentations (or, as in my case, have to sit through a lot of visitors' presentations) this money is very well spent. ■

Products Mentioned

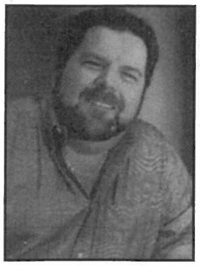
FotoMUGS!, $30 (Starter Kit of Four Mugs and Clamp)
Fargo Electronics, Inc.
7901 Flying Cloud Dr.
Eden Prarie, MN 55344
Tel.: 800-327-4690
CIRCLE NO. 41 ON FREE INFORMATION CARD

ColorScript 3000, $1,000 (MSRP)
CIRCLE NO. 142 ON FREE INFORMATION CARD

NEC Technologies, Inc.
1414 Massachusetts Ave.
Boxborough, MA 01719-2298
Tel.: 1-800-NEC-INFO
LCS-3210 Spatializer 3D Speakers, $119.99 (Estimated Street)
CIRCLE NO. 143 ON FREE INFORMATION CARD

Labtec
3801 NE 109 Ave.
Vancouver, WA 98682
Tel.: 360-896-2000
CIRCLE NO. 144 ON FREE INFORMATION CARD

TView, $449 (MSRP)
TView Inc.
7853 SW Cirrus Dr.
Beaverton, OR 97008
Tel.: 503-643-1662
CIRCLE NO. 145 ON FREE INFORMATION CARD



By Tom Benford

Multimedia

An inexpensive way to build a multimedia CD-ROM library; a new version of a fantastic MIDI music-creation program; and an updated version of a terrific application for building multimedia presentations

As you can see from the above title, this time around I have a mixed bag of items on which to report. So without further adieu, I'll jump right in.

CD-ROM Collections

I'm frequently asked by newcomers to the world of multimedia what the least-expensive way of building a well-rounded CD-ROM library is. I generally respond that it all depends on your tastes, since the genres of software you desire will ultimately affect cost. But I also add that there are ways to get around the high cost of purchasing CD-ROM software if you have a keen eye and know a bargain when you see one.

Sirius Publishing has some of the best CD-ROM software bargains available, and these aren't shareware collections or "B"-grade titles. Everything in the Sirius 5-Ft. 10 Pak Collections is a top-selling title. The assortment and variety of which they're composed guarantees there will be something in each for just about every taste.

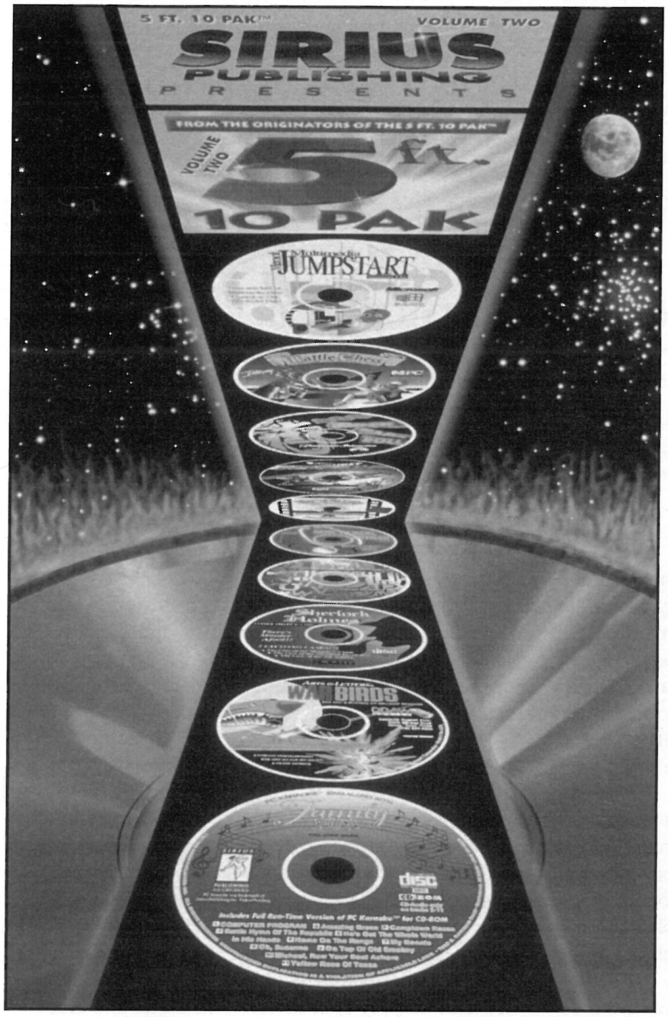
Early in 1994, Sirius introduced the first 5-Ft. 10-Pak, a five-foot-long compilation of 10 top-selling CD-ROM titles from different publishers. These programs were licensed and marketed in a cooperative effort to acquaint new and current users with the potential of CD-ROM software. It was a good idea whose time had come. Since then the 10 Pak has consistently remained near the top of the "Top Selling CD-ROMs" listings published by a variety of sources.

The original 5-Ft. 10 Pak was followed by Volume Two, then the Special Edition and now the Collector's Edition. A special six-disc assortment of children's titles was also released, called the 3-Ft. 6 Pak for Kids.

The 10 titles comprising Volume 1 include: *King's Quest V, Stellar 7, Time: Man of the Year, World Fact Book, Best of Media Clips, World Vista Atlas, PC Karaoke Classics, CD-ROM of CD-ROMs, PC Animation Festival* and *Doom: Shareware Episode One*. Volume II's contents include: *Sherlock Holmes Consulting Detective Vol. 1, Space Quest IV for CD, Battle Chess Enhanced, PC Karaoke Family Fun, Rock-Rap-'n-Roll, Multimedia Jumpstart, Movie Select for MPC, Home Medical Advisor v3.0, Arts & Letters War Birds* and *2,000 Fonts by Fantazia.*

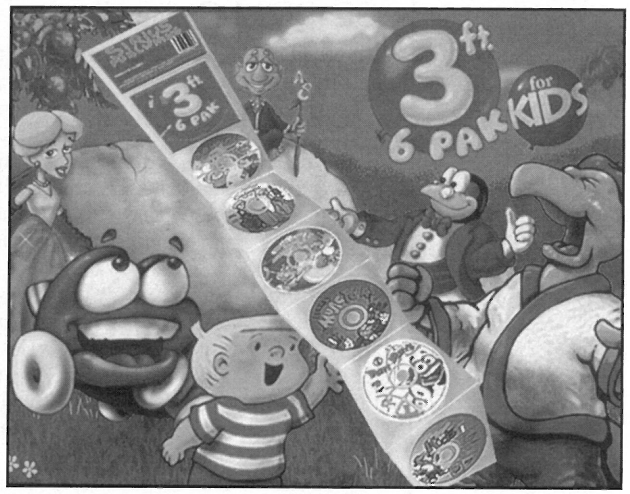
The 3-Ft. 6 Pak is a great assortment for kids and

Original 5-Ft. 10 Pak from Sirius Publishing caused a sensation in marketplace by offering 10 top-selling CD-ROMs for only $39.95. Packed in an accordion-fold packet, the 10 discs span 5-feet in length when stretched out, hence the name.



Volume 2 of the 5-Ft. 10 Pak continued the same packaging and pricing scheme as the original but brought such tasty titles as Microsoft's Multimedia *Jumpstart,* Home *Medical Advisor* and 2,000 Fonts into the assortment.

The 3-Ft. 6 Pak, a special collection for younger multimedia PC user(s) in your house, is an excellent way to help them build their computing skills while providing entertainment at the same time.



consists of: *Family Circus Our House, Lenny's Musictoons, Cinderella: The Original Fairy Tale; Putt Putt's Fun Pak, Basic Spelling Tricks* and *Sing-Along Kids.*

The Special Edition of the 5-Ft. 10 Pak's assortment is: *Beyond Planet Earth, Microsoft's Multimedia Mozart, Who Shot Johnny Rock?, Photomorph and Conversion Artist,* Sports Illustrated *1994 Multimedia Almanac, Hell Cab, PrintMaster Gold, Corridor 7 Alien Invasion, National Parks of America* and *Sing-Along Kids Volume 2.*

The latest 5-Ft. 10 Pak, dubbed the Collector's Edition, is the best yet. It contains *Exploring* Windows 95, *SiriusNet* (Internet utilities), *Webster's Concise Encyclopedia, Dragon's Lair, The Journeyman Project Turbo, Dr. Ruth's Encyclopedia, (Prince) Interactive, Introduction to Classical Music, Mad Dog McCree* and *Sing-Along Kids Volume 3.*

Considering that the 5-Ft. 10 Paks have a suggested retail price of just $39.95 per Pak, they certainly represent the best bargains and fastest way to amass a decent CD-ROM library without breaking the bank. Bear in mind, too, that all of these discs are the full versions—not sampler or demo versions. Even if there's only one disc in any of the 5-Ft. 10 Paks that interests you, you'd be hard pressed to buy a single CD-ROM for $39.95. Just think of it as buying the 5-Ft. 10 Pak for the title you want and getting the other nine discs free.

Each of the 5-Ft. 10 Paks also contains more that $100 worth of coupons toward the purchase of other CD-ROMs offered by the participating publishers and other accessory items, like jewel cases. Hence, the savings continue. Any way you slice it, Sirius has really put together some excellent CD-ROM assortments that make expanding your multimedia CD-ROM horizons easy and affordable.

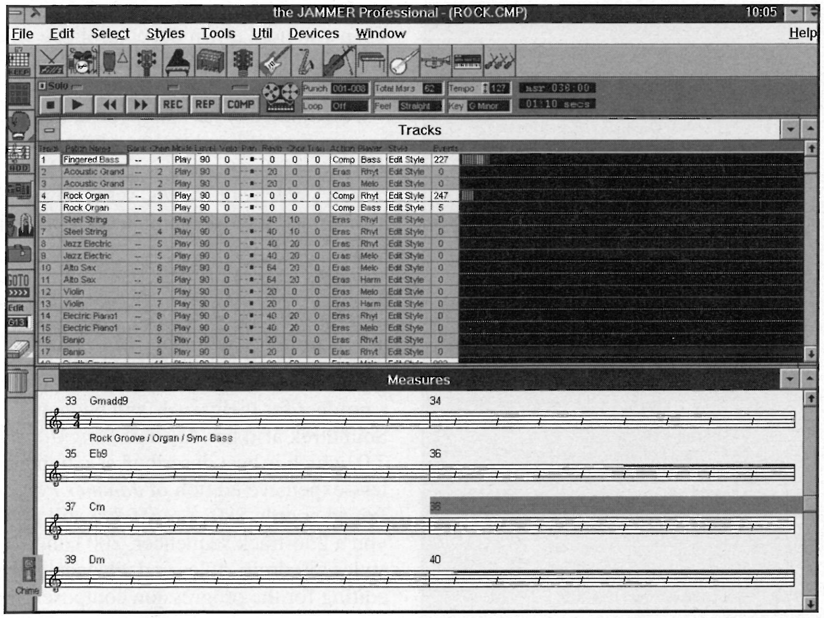
The Jammer Professional Version 2.0

Soundtrek has released Version 2.0 of its *The Jammer Professional* songmaker MIDI software. I'm happy to report that the company has made one of my favorite MIDI applications even better than the original.

With this program, anyone, even non-musicians, can easily create original, royalty-free songs they can use for multimedia presentations, background tracks, jingles, sound beds, practice jams and other applications. Previous knowledge of music and composition isn't necessary, since *Jammer* takes the drudgery out of making music and brings lots of musical virtuosity to the table.

Some of the feature highlights that make Version 2.0 an even more-versatile program than the original are of more than 200 added new band styles, the ability to load and save standard MIDI files, a six-part harmony composer, automatic fades and crescendos, the ability to load and save individual drum styles, *Windows* MIDI clipboard support, a new scale control that permits scale choices, scale tone patterns and scale repeat, custom timing patterns with wild cards, designated notes and bands, an effects control for modulation and pitch bend, and lots more.

Even with the increased capabilities and functionality of the program, Soundtrek has kept the easy-to-use interface and format for getting the program to do its thing



Main screen of *Jammer Pro* provides views of both the tracks window that shows the "musicians" currently active and measures window that shows what type of embellishments are being used for specific portions of a song. Toolbar at left edge provides easy access to such functions as punch recording composing, editing and more.

with a minimal user learning curve. There's also an excellent on-line tutorial that tells you what to do every step of the way, even if you're a total musical neophyte.

To begin a new song, you select "New" from the file menu. Before you can enter chords in your new song, you must first add some measures, which you do by clicking on the "Add Measures" button on the side toolbar. When the dialog box appears, choose your desired time signature, key signature and the number of measures you want. Then click the "OK" button. *Jammer*'s built-in "musicians" write parts based on the chord progression in the measures window. You can enter your own chords, or you can have *Jammer* generate chord progressions for you.

Entering and editing chords in *Jammer* are easily accomplished by moving the cursor in the measures window to the desired location, using either your mouse or the arrow keys on your keyboard. You then type in the chord you want and press the Enter key. Editing an entered chord is also easy to accomplish by clicking on the chord with your left mouse button and hitting Enter. You then use your keyboard to make any desired changes.

If you aren't feeling particularly creative, or you're just curious as to what the program can do, you can have *Jammer* generate chord progressions for you. To do this, you click on the "Progression Composer" button on the side toolbar with your right mouse button until it shows "Comp," and the next time you compose, chords will be written for you. To stop the program from composing chord progressions, you set the progression composer to "keep."

Before you can do any composing, the program needs to know the measures on which you want to work. You do this by selecting the desired measures and setting the punch. Measure selection is done by clicking your left mouse button on the first measure you want and dragging to the last desired measure. Releasing the mouse button locks in the selection.

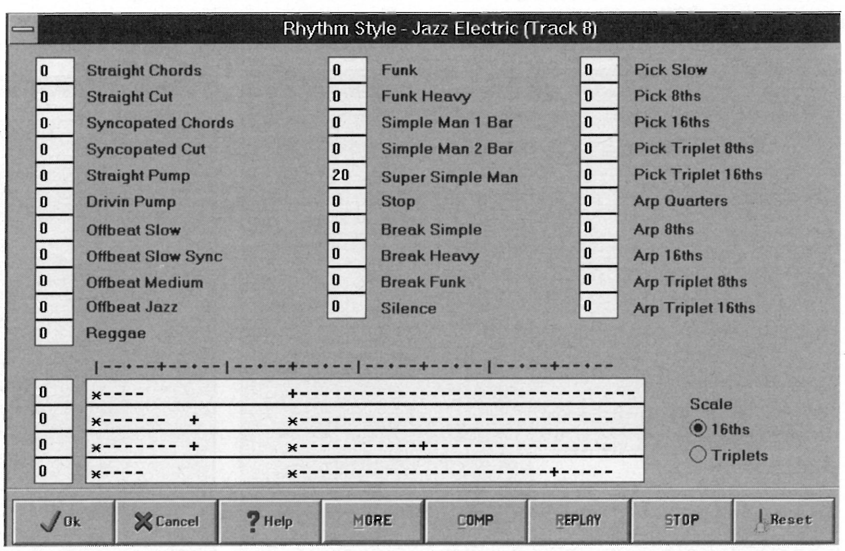
Punch can be set in either of two ways. The first is to click your mouse button anywhere inside the selected measures and drag them to the boxing-glove icon "punch" button on the side toolbar, releasing the button when it's over the icon.

The second method is to click the punch button first, but don't release your mouse button. A second toolbar then appears, and you can then release your mouse button while the mouse cursor is over the "set punch and loop" button. The measure numbers in the punch zone will then be displayed in red.

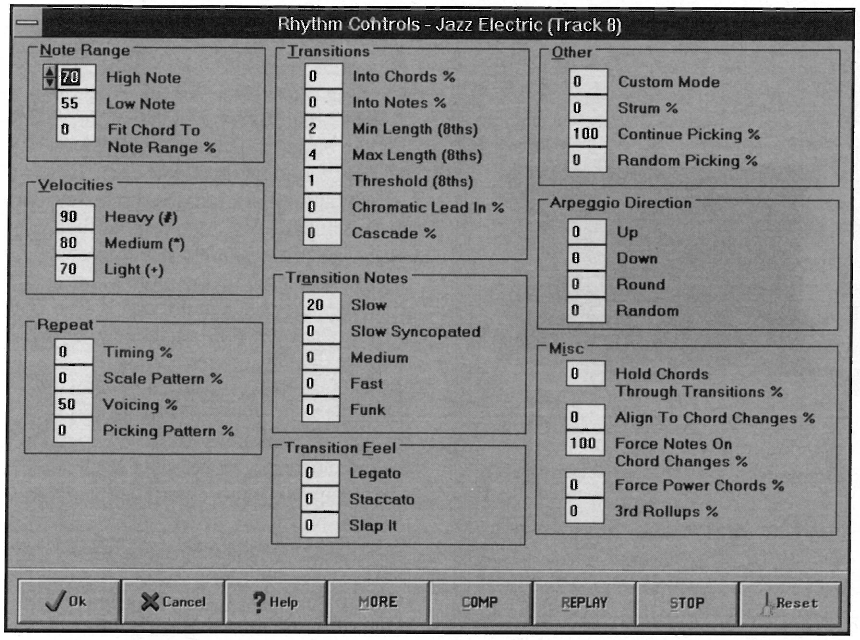
The fastest way to begin composing music is to use *Jammer*'s band styles. A band style contains a preset group of selected musicians on selected tracks that are set up to compose parts in the given style of music.

To load a band style, you click on the "load style" button on the side toolbar. You're presented with a list of the available styles. Within a given genre, you can choose from several part types, such as intros, grooves, breaks, stops and endings. If you want to preview a style, you merely click on the "load and compose" button. At this point, the program loads the style, composes the measures determined by your punch settings and plays the measures for you. When you've found a style you like, click the "OK" button to save it.

What really makes *Jammer* different from other auto-composition programs I've used is that it composes dynamic parts, rather than "canned" passages. Every time you compose, each musician uses the current style as a basis for writing parts. Some styles are more dynamic than others, but you'll generally get different



Double-clicking on electric-guitar icon at top of screen brings forth style-customization parameter screen for that instrument. An enormous amount of flexibility for tailoring style parameters for each instrument selection is given. Changing any parameter results in totally new, original "riffs" being created on the fly for that particular part. Since all parts are dynamically created, chance of program generating same passage twice is practically nil.



Clicking on More button at bottom of style customization screen for any given instrument produces second parameter-customization screen shown here. By altering such values as note range, velocities, transitions and other parameters, infinite variations in program's part generation algorithms are produced, guaranteeing that parts generated will be totally original and unique.

parts every time you compose. In other words, *Jammer* improvises.

You can add drum fill marks to let *Jammer* know where you want drum fills to be composed. Each time you compose, drum fills will be added in the measures that contain drum-fill marks. This is a really neat feature that adds lots of sparkle and gives the music an original feel, rather than the "drum-machine" monotony of preset beats and fill patterns.

To add or change a drum fill, you click your right mouse button on the measure you want to edit to bring up a pop-up menu. Then you select the type of drum fill you want. You can also toggle between no drum fill, short drum fill and long drum fill by using the CTRL+F keystroke combination.

If you want to compose a section within your punch, you just select the desired measures and click the compose button. Alternatively, you may want to compose on only certain tracks. You do this by selecting each track in the tracks window. Then you hold down the control key when you click the compose button, and only the selected tracks recompose.

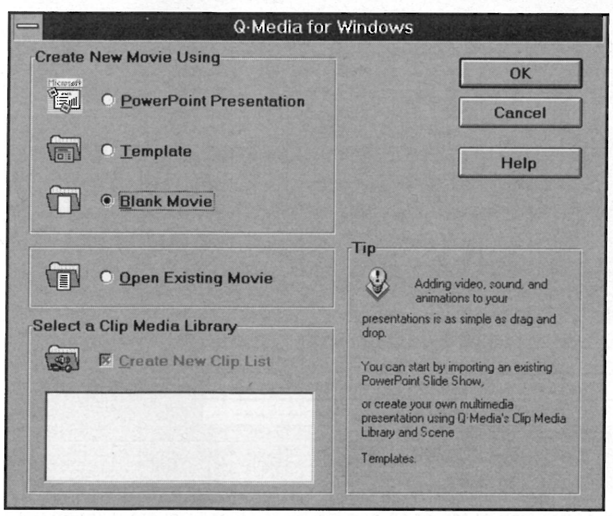
To complete your song, you can use any number of band styles, which also gives you lots of creative latitude. You merely enter your chords, set the punch, load a band style and compose. That's all there is to it!

While *Jammer Pro* 2.0 is full of rich features that any serious musician or composer will readily appreciate, the package may be more than some users will want or can use. To satisfy such users and supply a product for their needs and budgets, Soundtrek also has *Jammer SongMaker* 2.0, which is best described as a lighter, less-expensive edition of *Jammer Pro*. Priced at only $89, *SongMaker* still gives you a 256-track sequencer, 200 band styles, 50 drum styles and advanced style editing for the progression composer, harmony composer and duplicator composer, just like the *Pro* version.

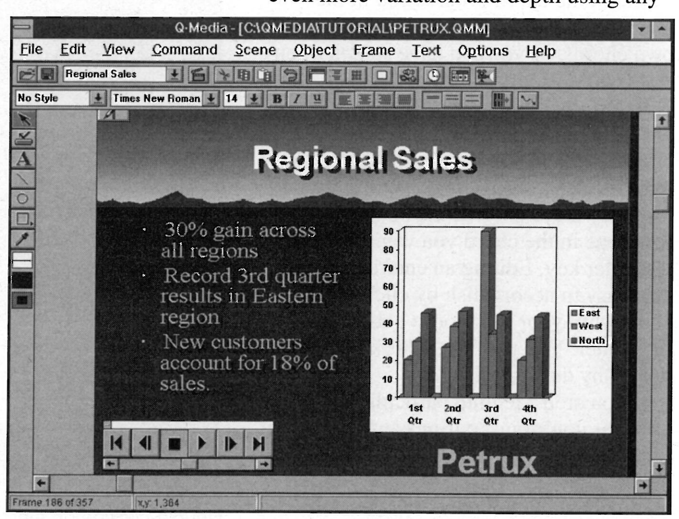
Features *SongMaker* version doesn't include are the advanced style editors for the bass, rhythm, melody, kick drum, share drum, percussion and drum fill composers. These are the really slick, high-end features that most users probably will never miss.

If even the *SongMaker* version sounds like more than you need or want to spring for, you might want to get *Jammer Hit Session* 2.0 that costs only $39. This is an even slimmer program that still gives you all of the sequencing and editing capabilities of the *SongMaker* version, except that it provides only 100 band styles, rather than *SongMaker*'s 200.

Other Soundtrek add-on products that are definitely worthwhile for giving you even more variation and depth using any



Q-Media 3.0 lets you create a moving presentation using your existing Microsoft *PowerPoint* Presentation files. Adding video, sound and animations is a simple matter of dragging elements in and dropping them where you want them to occur.



Q-Media 3.0's user interface is intuitive and utilizes toolbars at top and side for most frequently-performed operations. Ability to imbed OLE 2.0-based objects, such as charts and graphs, in presentations is another big plus of program that's sure to find favor with corporate users.

Jammer version described above include *Assorted Band Styles Volume I* that provides more than 70 additional band styles and consist of assorted intros, breaks, holds, stops and endings for such musical genres as ballads, jazz swing, rock, slow guitar blues, rhythm and blues, country, reggae and hip-hop. *Assorted Band Styles Volume 1* lists for $29.95.

Assorted Drum Styles Volume 1, also listing for $29.95, provides more than 100 assorted beats and fills that range from predictable to improvisational in the genres of jazz, rock, blues and country.

Soundtrek's slogan, "software created by musicians for musicians," is a true statement. The nuances of the tools, intuitive nature of the interface and adherence to "comfortable" musical conventions make these products easy for casual users to be creative and provide excellent composition packages for serious, experienced musicians. You can spend your time making and enjoying excellent music, rather than learning how to use the software. In the end, this is what it's really all about, isn't it?

Q-Media for Windows Release 3.0

Last year, I reviewed *Q-Media* Release 2.03 in this column and thought it was one of the easiest-to-use multimedia presentation-authoring packages I'd come across. While it didn't have the industrial-strength qualities or capabilities of Asymetrix *Multimedia Toolbook*, it's price tag was considerably less, and it had an excellent range of features that would be sufficient for many user needs.

Release 3.0 of *Q-Media* has significantly advanced multimedia capabilities and more than 50 new features, including import filters that permit you to make stand-alone multimedia presentations complete with sound and animation from your existing MS *PowerPoint* files, a feature that's sure to make it a hit with many corporate users.

Some of the noteworthy new features that have been added to *Q-Media* 3.0 include a path-based animation editing tool to assign motion paths to objects, more than 100 transition effects, an automatic file-compression and packaging utility for creating distributable presentation files, an enhanced animation player to support scaling and transparency for AutoDesk .FLC files, a print-to-video feature for transferring completed presentations to video tape (if you have the requisite hardware in your PC), the ability to link together multiple *Q-Media* presentation files and a smaller royalty-free runtime viewer application, among many other useful enhancements.

The file-handling capabilities of this new version are exceptionally rich, providing support for the following filetypes:

- **Presentation:** *PowerPoint* 3.0 and 4.0 files; *Windows* Metafile (.WMF)
- **Video:** .AVI, .AVS, .MOV, MPEG, Video Overlay
- **Animation:** .FLC, .FLI, .AWM, .AWI
- **Audio:** .WAV, MIDI, Riff MIDI, CD-Audio
- **Images:** .BMP, .WMF, .TIF, .GIF, .PCX, .DIB, .TGA, JPEG, .WPG, PICT, .EPS, .DCX

A rich assortment of sample media clip files is provided to help get you off to a running start, as is an excellent tutorial that uses a learn-by-doing approach. More than 60 professionally-designed templates are provided to build your presentations quickly, and the clip library includes 50 .AVI videos, 100 clipart images, 477 .WAV audio files, 150 MIDI files, 136 photo images and 100 animation files. All can be used royalty-free in your own productions.

The Player permits support of CD-audio, video, animations, OLE objects and more. Support for Kodak PhotoCD and four-, eight-, 16- and 24-bit color is also provided.

One of the nicest features of the package is *Q-Media*'s File Packager, which automatically compresses the files and splits them up over multiple disks for distribution. Since the runtime player is also royalty-free, you can freely distribute your productions.

For less than $200, *Q-Media* 3.0 packs an incredibly big punch in the features and capabilities it delivers, all with a very easy-to-use interface. This package is a winner, for sure!

Products Mentioned

5-Ft. 10 Paks and 3-Ft. 6 Pak CD-ROM Assortments, $39.95 Each
Sirius Publishing Inc.
7320 E. Butherus Dr., Ste. 100
Scottsdale, AZ 85260
Tel.: 602-951-3288

CIRCLE NO. 150 ON FREE INFORMATION CARD

Jammer Professional Version 2.0 and Other *Jammer* (2.0 Versions)
Soundtrek
3408 Howell St., Suite F
Duluth, GA 30136
Tel.: 800-778-6859

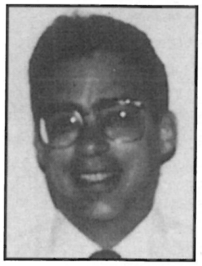
CIRCLE NO. 151 ON FREE INFORMATION CARD

Q-Media for Windows 3.0, $199
Q-Media Software Corp.
312 E. Fifth Ave.
Vancouver, B.C., Canada V5T 1H4
Tel.: 604-879-1190

CIRCLE NO. 152 ON FREE INFORMATION CARD

Computing On the Go

Great Expectations



By Joe Desposito

Working with a 90-MHz Pentium desktop PC has made me more and more conscious of the performance limitations of my Toshiba T3400CT ultra notebook computer, which employs a 486 processor running at 33 MHz. In particular, I'm dissatisfied with the way *PageMaker* 5.0 runs on the notebook. So I've been looking for ways to juice up performance.

One upgrade I'll probably make in the near future is to increase RAM memory from the current 4M to 8M. I expect this will increase performance. Right now, there's a substantial amount of hard-disk activity as programs make use of *Windows*' virtual-memory swapfile. This, of course, slows down operations.

I'm also mulling over the switch to *Windows 95*. I work with four computers on a regular basis. In the office are two desktops, the 90-MHz Pentium and a 66-MHz 486. At home is a 486SX/33 and, of course, the notebook. I loaded *Windows 95* on only one of these—the 486/66 in the office.

Since the Pentium PC is the machine on which I do the bulk of my work, I couldn't afford any downtime that might be caused by a *Windows 95* learning curve. The 486/66 is used by part-time help a couple of days a week. I felt I could afford downtime on this machine, if it occurred.

Before I installed *Windows 95* on this computer, I upgraded RAM from 4M to 8M. I'll probably switch the Pentium to *Windows 95* in the near future, but I won't do it before I upgrade the memory on this machine from 8M to 16M. After this is done, I'll be left with two computers that will be running older versions of *Windows*.

My 486SX/33 home machine is still running *Windows* 3.1. I'll need to upgrade memory on this computer to 8M and the hard disk as well from its current capacity of only 180M. But I'll wait to see how well or poorly *Windows 95* performs on a 486SX/33-class machine before making any moves.

Right now, my notebook PC is operating under *Windows for Workgroups* 3.11. Switching this computer to *Windows 95* also requires a memory and hard-disk upgrade.

I don't intend to upgrade the hard disk from its 120M capacity. Instead, I've used a compression program to increase the capacity to about 218M. Though this is a small capacity figure nowadays, it will have to do. I'll probably buy another notebook in a year or two. Even then I won't discard the T3400CT. Instead, I'll pass it on to someone for use as a word processor or other similar application that doesn't strain the resources of the machine.

In the meantime, I'm faced with a host of decisions that will cost me hundreds and hundreds of dollars in upgrades. Due to this, I'm constantly on the lookout for products that might prove to be a more cost-effective way to wring extra performance from my slower computers. It's with these thoughts that I tried out the latest product from Helix Software—*Hurricane*.

The product I looked at is designed for 386 or greater PCs running *Windows* 3.1/3.11 and *Windows for Workgroups* 3.11. By now, the *Windows 95* version should also be available. On the front of the box in bold letters is the statement "The Easiest Way to Make Your Computer Faster." *Hurricane* retails for $79.95.

Hurricane is a set of utilities that are designed to enhance *Windows* memory and speed up *Windows* performance. These tools are completely automatic and self-configuring, and they're supposed to provide substantial performance and reliability improvements to any *Windows* system. In addition, *Hurricane* provides a sophisticated set of information tools—Discover for Windows and WinGauge (Fig. 1 and Fig. 2).

The *Hurricane* utilities break through the *Windows* resource and memory limitations, making more memory available to each application and providing virtually unlimited resources. To speed up your system, *Hurricane* includes utilities to accelerate video performance, improve 32-bit file access and provide 32-bit caching of all system drives. Also included are utilities to accelerate the internal work-

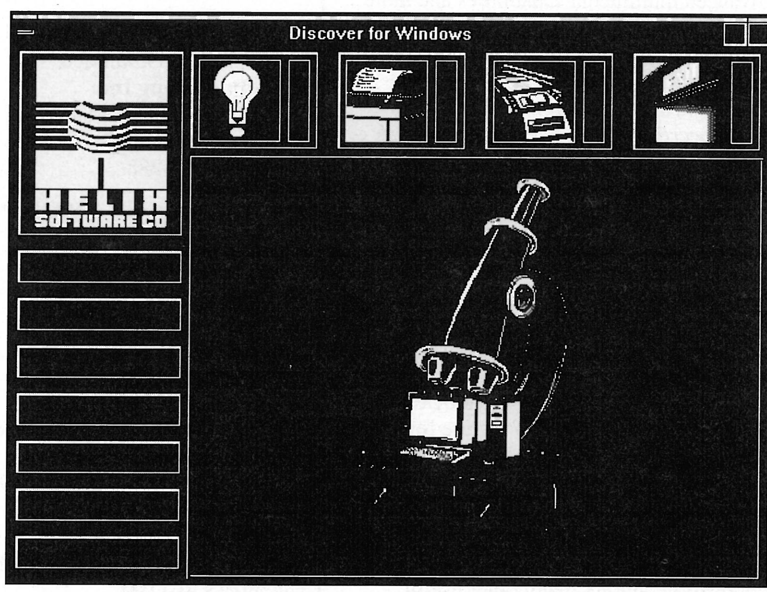


Fig. 1. *Hurricane*'s Discover for Windows utility.

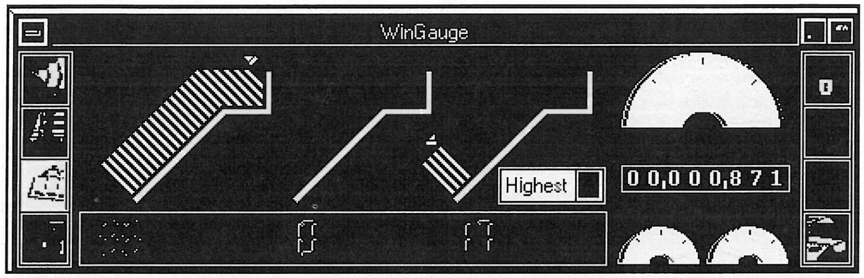


Fig. 2. *Hurricane*'s WinGauge utility.

Table 1. Performance of PageMaker on 486/33 Toshiba T3400CT Ultra Notebook PC With & Without Hurricane Installed

Test	Without *Hurricane*	With *Hurricane*[1]	With *Hurricane*[2]
Load *PageMaker*	38.1	100.6	44.4
Load Template File	26.9	39.7	23.2
Place Text	10.2	19.2	11.4
Change Pages	3.8	6.5	1.5
Change Views	2.1	4.0	2.4
Save File	9.7	11.6	5.9
Load File	18.4	31.0	13.8
Close File	3.6	5.8	2.9
Close *PageMaker*	11.5	19.3	9.7

[1]No changes in Virtual Memory or SMARTDRV
[2]Change Virtual Memory Cache Size to 512K

ings of *Windows* using Helix Software's patented technology.

Should you need or want to find out in detail what's going on inside your system, the system-analysis tools of Discover for Windows provide detailed information about software, memory, system components, disk drives and I/O devices, as well as a series of benchmarks. Figure 3 shows a typical screen for information about system-memory use.

WinGauge keeps track of applications and warns you of potential problems. It's a dynamic reporting tool that constantly monitors your use of *Windows*. Graphical meters show how much of your critical resources you've used, and warning indicators activate when any critical resource reaches a dangerously low level.

The product's user manual clearly explains program operation and includes an "Understanding Windows Memory" tutorial. This is for informational purposes only, as *Hurricane*'s configuration utility and defaults are designed so that they won't require any "tweaking."

Figure 4 shows the *Hurricane* control center, which provides a central location for setting all of the controls and options for the various utilities (although these are already set when you first install the program). As you can see, all of *Hurricane*'s utilities are presented on a single screen in the Control Center. This screen contains "tabs" that reference each utility (along the top and bottom). All you have to do is click on a tab to display the utility's specific selection and activation controls.

Note in Fig. 4 that there's an "x" in the Heap Expander box. This means that the utility is installed. If you don't know what a "heap" is, the manual explains this technical term. Briefly, *Windows* consists of three components: the Kernel program that's responsible for the multitasking of *Windows* programs; the User program that's responsible for managing windows, buttons, controls and menus; and the GDI program that's responsible for drawing graphics on the screen or printer.

One of the many tasks assigned to the *Windows* Kernel is allocating something called "Linear Memory." Linear Memory is neither physical memory (RAM) nor virtual memory (hard-disk space). Linear Memory is an artificial kind of memory. When *Windows* loads, it takes the "free" physical memory available to it and multiplies by four (in most cases). From then on, this number is the actual maximum amount of memory available to all programs running under *Windows* and is designated Linear Memory.

The Kernel is in charge of carving off chunks of Linear Memory and doling them out to applications upon request. All the Linear Memory that has been allocated by the Kernel is called the "Global Heap." Local Heaps are small 64K chunks of the Global Heap for use by individual programs.

The Heap Expander is one of the most-powerful of *Hurricane*'s utilities. It solves the "out of memory" problems associated with running several *Windows* applications by providing virtually unlimited resources to *Windows*. The Heap Expander is configurable so that it can be set to activate only when your system becomes low on resources. You set this by controlling the GDI/User threshold options shown in Fig. 4.

On the back of the box in which *Hurricane* is packaged is a listing of *Hurricane* tools. Under Heap Expander are four bul-

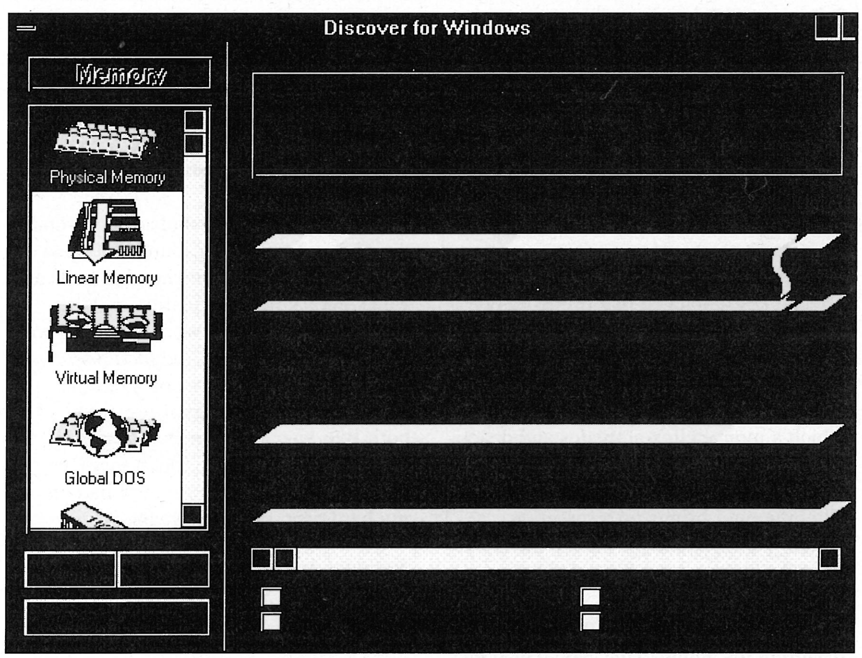


Fig. 3. Discover for Windows information about system memory use.

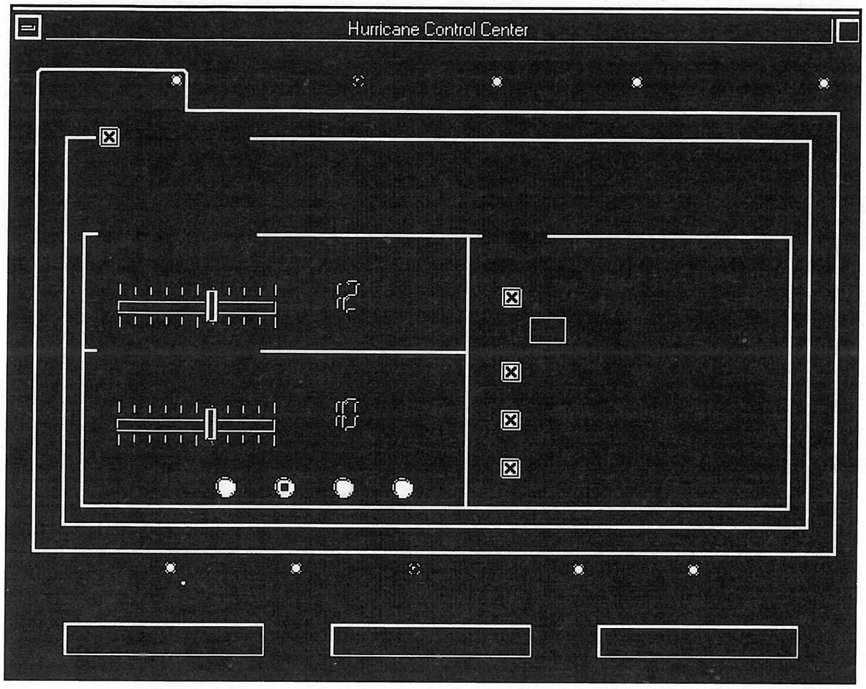


Fig. 4. *Hurricane* Control Center.

leted items: Provides "unlimited" resources; "doubles" your RAM; automatically cleans up after applications; and automatically frees unused application memory.

Since I have a 4M system, I was interested in finding out whether or not I could save on purchasing another 4M of physical RAM by using *Hurricane*'s RAM-doubling feature. With a free upgrade to the *Windows 95* version of the software included in the price, I thought *Hurricane* might provide me with an inexpensive way to migrate to *Windows 95* for this machine. After using *Hurricane*, I'm still not sure of the answer to this question, although I did find out the answer to my original question about performance.

To check whether *Hurricane* does, indeed, make a computer faster, I first ran some performance tests—without *Hurricane* installed. Since I'm interested mainly in improving the performance of *PageMaker* 5.0, I ran a battery of tests, as shown in the first column in Table 1. After running the tests, I installed *Hurricane*. This is the easy part. Once installation is complete, you don't have to do a thing, not even load the program!

I re-ran the tests and got the results listed in the second column of Table 1. What a surprise! With *Hurricane* installed, every test was significantly *slower* that without *Hurricane* installed.

I called Helix support and asked why. The answer, basically, is that *Hurricane* will improve the speed of operations only on 8M and greater systems, although it will improve *Windows*' ability to open more applications, even on 4M systems. Fortunately, this isn't a high priority of mine on this particular system.

The technical-support person I spoke to gave me some additional advice to help bring the performance standards back at least to where they were before I installed *Hurricane*. First, he told me to reduce the setting of the *Windows* Virtual Memory Cache Size from 1,024K to 512K. Then he suggested that I reduce SMARTDRV to 128K or 0K for *Windows* operation (since I already had it set at 128K, I left it that way).

I implemented these changes and ran the tests again. This time, *Hurricane* improved performance in six of the nine tests. Encouraged by this, I lowered the SMARTDRV setting to 0K to determine if performance would improve further. I changed the statement in my AUTOEXEC.BAT file to read: LH SMARTDRV.EXE /X 1024 0.

Then I rebooted the system and ran the tests one more time. Of the three slower tests, just one achieved better performance than was available before the *Hurricane* installation—Change Views. This gave a total of seven out of the nine tests with improved performance.

I think *Hurricane* is a product that succeeds on several levels. For the most part, it increases performance, even on a 4M system. It will also help you run more applications than before. Finally, it provides you with a great deal of information about how your system is operating. I'm now looking forward to upping system RAM in the T3400CT to 8M and eventually switching to *Windows 95*. ■

Bits 'n' Pieces **By Alexander W. Burawa** *(from page 79)*

Clicking on the Password tab at the bottom of the screen lets you use password protection. Use this screen to enable, disable and set a password for the screen-saver program. Once you enable password protection, you can't get back to your *Windows* desktop without typing in the correct password.

Clicking on the Hot Keys tab lets you select a key sequence that immediately blanks the screen or/and one that saves the screen image to your wallpaper. Click on the Hot Corners tab, and you can select the corners of the screen in which a mouse click activates and deactivates the screen-saver utility.

The final tab is labeled Advanced. Clicking on it brings up a screen in which you fine-tune the screen-saver system. Check boxes are provided for saving the image in DOS full screen, waking your PC with any mouse movement and disabling the sound. This screen also has a Display Power Management section in which you can activate power management, use Energy Star compliance and shut down your video monitor after 5 p.m. You can set high, medium or low sensitivity for your system activity monitor and enter the time after which the screen saver signals your video monitor to go into energy-saving mode.

With superb screen shots of birds and their habitats, pleasing sounds (not just bird calls, but wind and clanging bells as well), interesting information and the power to make things work the way I want them to, this *National Audubon Society Wild Birds Screen Saver* program has become my all-time favorite—and its both *Windows* 3.1- and *Windows 95*-compatible. I like it so much that I've wiped all other screen savers I had on my hard disk, some for years.

National Audubon Society Wild Birds Screen Saver, $29.95 (Street)
BOCA*Soft*
301 Yamato Rd., Ste. 2180
Boca Raton, FL 33431,
Tel.: 407-241-1812; fax: 407-241-6301

CIRCLE NO. 132 ON FREE INFORMATION CARD

Product Mentioned

Hurricane
Helix Software Co.
4709 30 St.
Long Island City, NY 11101
Tel.: 800-451-0551 or 718-392-3100

CIRCLE NO. 133 ON FREE INFORMATION CARD

Microcomputer Q&A

By TJ Byers

In this column, I answer questions about all aspects of computer disciplines, both hardware and software, plus related electronic queries. You can reach me on America Online at TJBYERS, on CompuServe or Internet at TJBYERS @aol.com or by mail at *MicroComputer Journal,* 76 North Broadway, Hicksville, NY 11801.

Can't Install MicroComputer Journal CD-ROM

Q. *I purchased the* MicroComputer Journal *CD-ROM, only to discover that I can't load it into my system. I keep getting the error message, "COMMDLG.DLL in use. Please close all applications and re-attempt Setup" (Fig. 1). I've searched all my* Windows *.INI files and I can't find this file mentioned anywhere. So who's using it, and how do I close it?*—H. Greenberg, Chicago, IL

A. COMMDLG.DLL is used by Common Dialog Boxes. Common dialog boxes aren't an application or an accessory but, rather, a dynamic-link library (DLL) consisting of functions that enable developers of *Windows*-based applications to provide the same look and feel for different *Windows* applications. The dynamic-link library COMMDLG.DLL provides a default procedure and template for each type of common dialog box. When the COMMDLG.DLL is in use, it can't be accessed by a setup routine—like the one used by the *MicroComputer Journal* CD-ROM.

You didn't mention how your system is configured, but I suspect it has a sound card. Quite often, it's a program that uses hot-keys, like a sound card, that's using the dynamic link, even though the application appears to be closed. I found that if you simply click on Ignore, the installation will continue smoothly.

Another snafu you may experience during setup is the message, "Error occurred while attempting to copy file. Could not locate file: '*x*:\MVCL13N.DLL'" (Fig. 2). This is because the file doesn't exist on the CD-ROM. The cure is to install the *MicroComputer Journal* CD from the supplied floppy disk, which has the file, or run the Minimum Setup option from the CD. You don't lose anything by using the Mini-

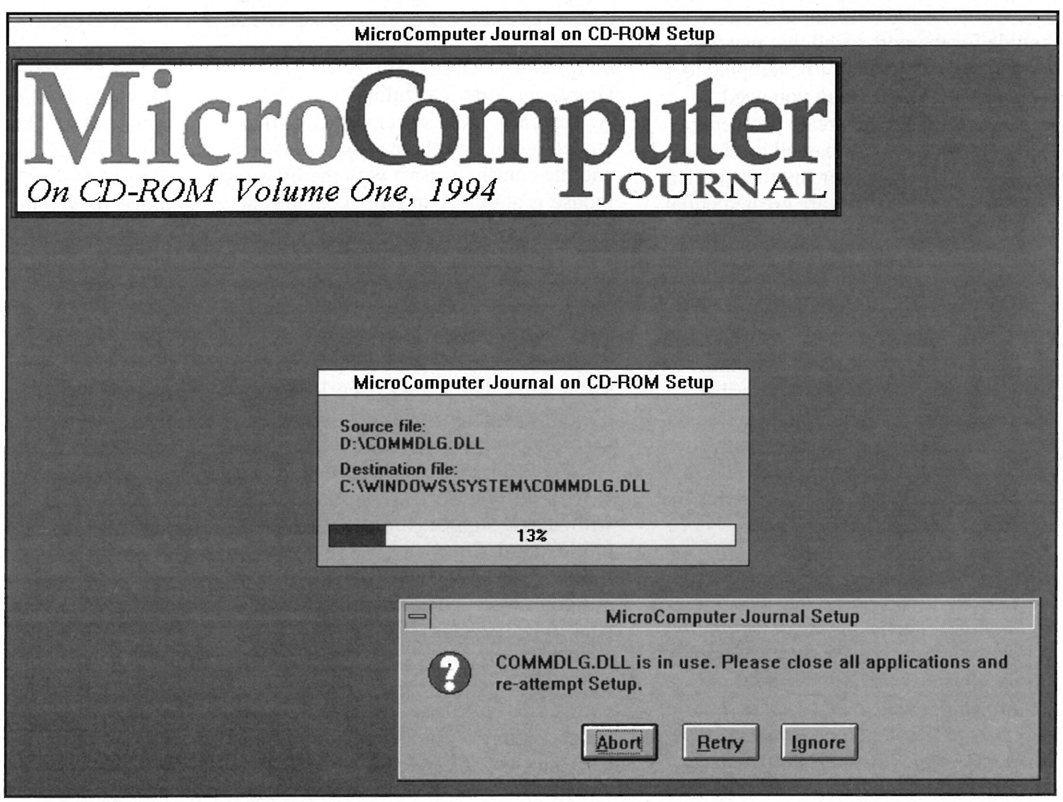


Fig. 1. If you get this error message when trying to install *MicroComputer Journal* CD-ROM, click on Ignore to proceed.

mum Setup option, except for a minor speed hit on older CD-ROM drives, and it takes up a lot less hard disk space (160K versus 2M).

Web Crashes Modem

Q. *While reading through the "Fast Modems" article by Hardin Brothers in the September/October issue of* MicroComputer Journal, *I was very interested in the SYSTEM.INI file fix for* Windows *3.1 Fast Communications because I constantly get COM-port overrun errors when I log on to the Web (WWW) at 28.8K. I have* Windows for Workgroups *3.11 instead of* Windows *3.1, and this software patch doesn't help at all. Is there anything I can do to improve my system's performance?*—Bruce Buckley, via Internet

A. Basically, *Windows* 3.1 and *Windows for Workgroups* 3.11 are identical in this area. Hence, the problem isn't in the patch. You didn't mention if the modem is internal or external. If it's external, I'd first check the COM port by typing MSD from a DOS prompt and clicking on Ports. If your modem port doesn't have a 16550 UART, you need to upgrade it. You can buy a new I/O card, most with floppy and EIDE disk-drive controllers included, for about $20 to $40.

The next thing to do is to start *Windows* and go into Main/Setup/Ports. Check your port speed for the modem. Use Table 1 as a guide for the port speed that matches your modem type. Don't be tempted to set the port speed faster than you need because this, too, can create problems.

If your modem port passed these tests, I suggest you look at your Internet service. Not all WWW services are created equal. In Southern California alone, they number in the scores, and it could be that the WWW interface is overloaded or that the software is poorly written—especially if the price of the service seems too good to be true. The way to test this is to take advantage of a rival's new-subscriber offer that often gives you several free on-line hours. If the problem persists, you might consider the modem itself. I've tested more than a few low-cost modems that stumble at 28.8K.

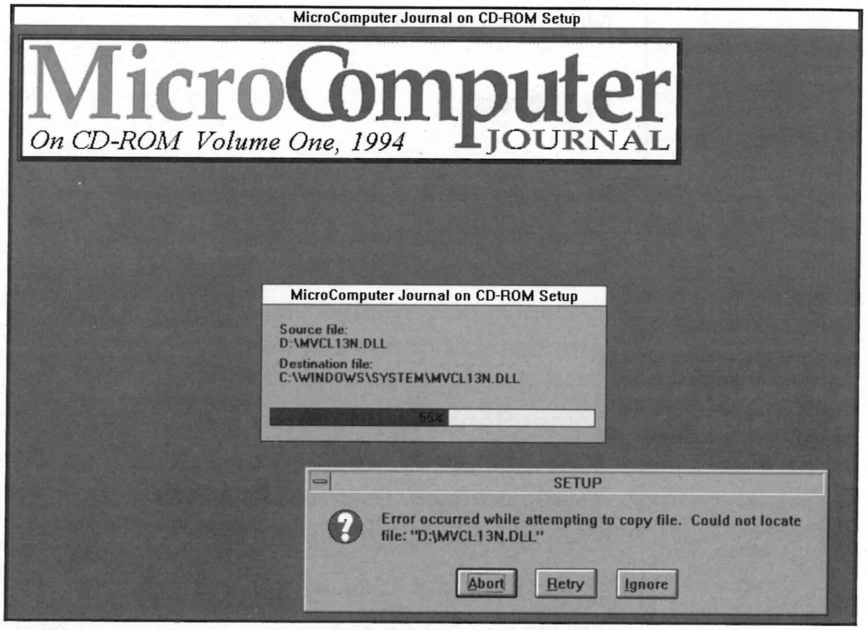


Fig. 2. If you get this error message when trying to install *MicroComputer Journal* CD-ROM, quit and install the program from floppy disk or run the Minimum setup option from the CD.

Table 1. Modem Type, Modem Speed & Port Speed

Modem Type	Modem Speed	Port Speed
V.32	9,600	19,200
V.32bis	114.4K	38,400
V.34	28.8K	57,600

AOL Stalls Mouse

Q. *My mouse works perfectly with all my* Windows *programs, except for America Online. Immediately after entering my password, the mouse locks up, and the only way to free it is to use the keyboard <Alt><F><X> sequence, which quits AOL and starts the mouse working again. I have the mouse on COM1 and the modem on COM3. I suspect an IRQ conflict. How do I find the conflict and fix it?*—A. Grant, via America Online.

A. I recently did a system upgrade that landed me in exactly the same situation, and the conflict wasn't with the IRQs (my mouse is at COM1 and the modem is at COM3). Basically, I added a 1.6G enhanced IDE (EIDE) hard disk to my system, which required a new EIDE controller and special software drivers. However, the controller I bought also included enhanced parallel and enhanced serial ports. Three days later, I still couldn't get the mouse to work with AOL, despite heroic efforts and many calls to AOL tech support. At this point, I decided to try a different EIDE controller card, one without I/O support, and went back to my old I/O card. Surprisingly, the AOL mouse came back to life.

I don't have a clue as to why this happens, but I've heard this same complaint/solution from other AOL subscribers—some combo cards simply won't work with AOL. Needless to say, AOL insists the problem isn't in its software, and the hardware vendor swears there's nothing wrong with the card. But since I made the change, everything works fine. I hope it works for you, too. If not, set your modem to COM4 and AOL to COM2. This sometimes solves the problem—again, why I don't know, but I've noticed the problem is most prevalent with motherboards that use an Award BIOS and run at 33 MHz and faster.

Increasing Conventional Memory Size

Q. *When working in* Windows, *my system sometimes locks up for no apparent reason. I first thought the problem was caused by lack of RAM. So I added 8M more, for a total of 16M, but it didn't solve the problem. Next I ran Gateway's* QAPlus Diagnostic *program that came with my system, and it reported no errors. Finally, I ran* WinTune, *a* Windows *program that diagnosed the problem as "Very little memory below 1M in the Windows Virtual Machine," and it suggested removing some TSRs and device drivers. I used REM in the CONFIG.SYS and AUTOEXEC.BAT files to restrict loading of all but the most-important programs (like HIMEM.SYS) with no luck. So what's the problem?*—L. Moore, via America Online

A. *WinTune* (Fig. 3) is quite correct in its interpretation of the problem. *Windows* uses fixed 64K blocks of memory below 1M to track *Windows'* resources. If even one of these blocks runs out of memory, though, you'll get this type of behavior. It's important to understand that, no matter how much RAM you add to your computer, these system-resource blocks don't grow in size. There are a couple things you can do to optimize your memory blocks.

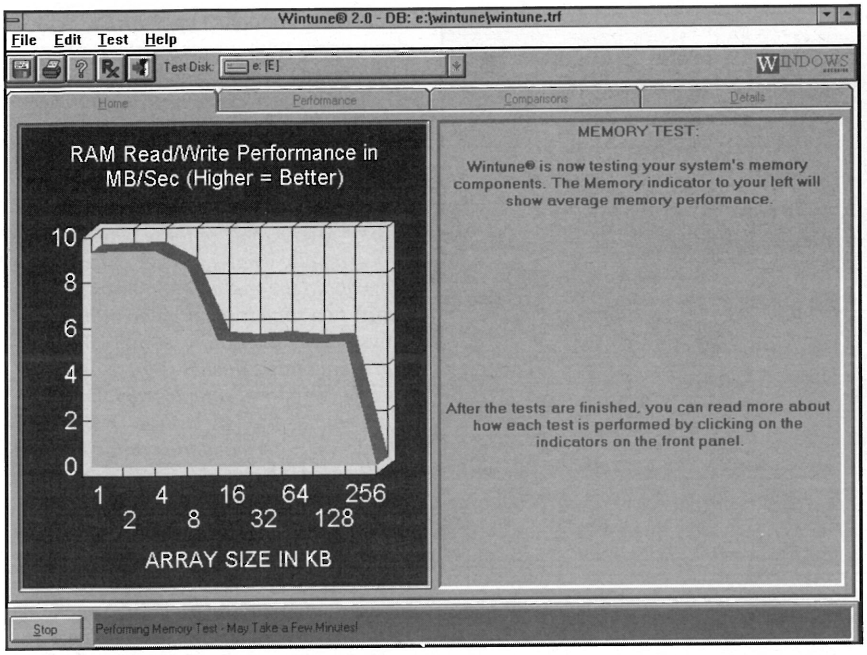


Fig. 3. *Windows'* WinTune diagnostic program can ferret out hard-to-find memory problems, as well as rate performance of your system and its parts. You can download it from: http://techweb.cmp.com/win/ software/wintune/wt20.zip.

First try running MemMaker, DOS's memory-manager program. MemMaker searches your upper memory area—the memory between 640K and 1,024K, called Upper Memory Blocks (UMBs)—and use this area to load your TSRs and device drivers. This frees memory below 640K, which *Windows* will now use.

When running MemMaker, use the Custom routine, not the default setup. In Custom, there's a menu that asks if you want to reserve an area in upper memory for *Windows*; the answer is "Yes."

Another solution is to install a RAM doubler, a software program that typically doubles the effective capacity of the *Windows* GDI and User system resources by compressing them using an algorithm. I suggest *MoreMem*, a shareware program that can be found on AOL and CompuServe, or *RAM Doubler* from Connectix Corp. (tel.: 800-950-5880).

Windows 95 Memory Problems

Q. *After successfully loading and running* Windows 95, *I now get an "Insufficient Memory..." message. So I added another 8M of RAM to my system, to bring it up to 16M, but the message persist, and I can't figure out why. I'm using* SoftRAM95, *a RAM doubler and no third-party memory manager.*—Ray Shore, San Jose, CA

A. Like *Windows* 3.1, *Windows 95* uses a fair amount of memory below 1M—generally to make *Windows 95* compatible with DOS and existing *Windows* applications. Again, this memory is allocated in 64K blocks to make everything backward-compatible, and when a memory block is full, you get this error message. Given the fact that *Windows 95* ran at first but doesn't now, it sounds like you're trying to load VSHARE or some other *Windows* 3.1 "lingering" TSR. In effect, more than two drivers are vying for the same memory block.

You may have caused the problem yourself if you removed the REM that *Windows 95* added to your start-up files, or it can be the result of installing an application without the services of *Windows 95*'s install/uninstall routine. I suggest you remove *SoftRAM95* and reload *Windows 95* (I know it's a pain; I've done it *way too many* times, myself) and choose Express Setup. You won't loose a thing except the extra baggage.

Windows 95 isn't the *Windows* we've all come to love and hate, so don't treat it as such. A lot of the add-on utilities are already built-in, and your effort to make it "*Windows* 3.1"-compatible may be killing it.

Customize With a Programmable Keyboard

Q. *I'm presently building a custom interface that duplicates keyboard data to a 486 motherboard. It's my understanding that keyboard data is synchronous serial data. If this is the case, at what rate? Also, is the keyboard clock always present, or does it exist only when there's data to transmit to the motherboard?*—Hazard, via Internet

A. The keyboard is actually a small computer in itself. Controlling the keyboard is an Intel 8042 microprocessor that coordinates all keyboard operations. This processor detects pressed keys by constantly scanning the keys to see whether they're in a make or break condition. When a key is detected in make mode, its code is sent to the PC by generating an interrupt signal and transmitting the scan line number of the key detected. Releasing the key sends a break code.

Data communication between keyboard and PC is bidirectional asynchronous and consists of an 11-bit word. The BIOS typically responds to a keyboard interrupt within 20 ms, depending on the demands on the CPU, which has to clear the keyboard's buffer. Communication between PC and keyboard are carried through I/O ports 60h and 64h, input and output, respectively. And don't forget that the keyboard's I/O ports are open-collector, which means you have to simulate pull-up-resistor logic.

If you don't understand *everything* I just detailed, then what you need is a programmable keyboard instead, like the Maxi Pro-II from Maxi Switch (Fig. 4). It has its own battery-powered memory that can be used to store up to 1,800 keystrokes that are played back by pressing a single key. Moreover, you can save keyboard macros to a disk, which makes it easy to switch between different keyboard layouts by simply downloading the saved routines.

PCI Versus VL-Bus

Q. *I realize that ISA is the old bus, but I'm confused about the difference between PCI and VL (VESA) bus. My PC has a VL slot, but my documentation makes no reference to PCI, which are the only video cards my local dealer sells. He says the VL-Bus is obsolete. So what video cards can I use?*—Jane Moorehead, via America Online

A. The VL-Bus is the first local-bus standard approved by VESA. When most vendors were pushing VL-Bus in the early 1990s, Intel was busy putting the finishing touches on the PCI local bus, which has since become the local bus of choice for performance reasons. However, the VL-Bus is far from dead. Just last week, I bought a new VL-Bus motherboard made by Genoa, and the dealer who sold it to me deals only in VL-Bus peripherals. He doesn't sell PCI products. On the other hand, the guy around the corner sells both

Fig. 4. If you're looking for a way to create a customized keyboard interface, I suggest a programmable keyboard like Maxi Pro-II from Maxi Switch (tel.: 602-746-9378).

(although the selections are more limited because of having to stock a larger inventory), and I go to him when I need a PCI card for my Pentium system.

Essentially, the two local-bus cards aren't interchangeable, and there aren't any conversion adapters. Now the question is: where can you find a VL-Bus video card. Actually, they're quite plentiful and are made by manufacturers like ATI (tel.: 905-882-2600), Diamond (tel.: 408-325-7000) and Orchid (tel.: 800-767-2443). If push comes to shove, you can always plug an ISA video card into your system. Some of the newer ISA cards are pretty fast, albeit not as fast as VL-Bus video.

If It Ain't Broke, Don't Fix It!

Q. *I recently decided to work on my parents' PC after I discovered that it wouldn't properly shift from 8 MHz to 33 MHz when turbo selection was made from the keyboard. I made a jumper connection that should have placed the system in the 33-MHz mode all the time. But, to my surprise, the computer now sometimes comes up at 33 MHz and sometimes at 8 MHz. Please help me.*—A struggling College Student, via Internet

A. Don't feel estranged. Often, a little knowledge is more dangerous than no knowledge at all, and this sort of thing occurs all the time. As a rule, the boot speed of the system, high or low, is stored in the CMOS setup routine. Simply changing a jumper doesn't mean a lot, because the CMOS has the ability to override it. Furthermore, it's possible you changed a CPU clock or memory speed jumper instead. I suggest you put the jumper back the way it was, pull up the CMOS screen and then make your selection from there.

As to why the keyboard keys don't shift the speed correctly, might I ask why you want to shift it. It's been a long time since I've seen a program that needs to run at 8 MHz, and it was a game written in 1986. Today's programs don't have this restriction and will run quite well at full speed. Hope this gets you off the hook.

Stop the Memory Checks!

Q. *I added another 8M to my system, bringing the total up to 24M, and I'm impressed with the performance of some applications—especially* MS Office. *However, I'm less than thrilled with the time it takes for HIMEM to test the extended memory. Is there anyway to speed up this operation—or eliminate the step altogether?*—Gavin Powers, St. Louis, MO

A. To bypass the HIMEM extended memory test, use an ASCII editor and change the CONFIG.SYS line that reads DEVICE=C:\DOS\HIMEM.SYS to DEVICE=C:\DOS\HIMEM.SYS /TESTMEM: OFF

From Braying to Brahms

Q. *My roommate recently installed a Sound Blaster card in her PC and instantly headed for the Sound icon under the* Windows *Main/Control Panel menu. Well, now her computer sounds like a barnyard orchestrated by the philharmonic, with highlighted sundry sounds—and it's driving both of us up the wall.* Windows *opens with a cannon blast. After this, various* Windows *operations are littered with cocks crowing, cows mooing, The 1812 Overture (which lasts 10 seconds, and a mule hee-hawing, to mention but a few. The problem is that neither of us can figure out the original sound pattern or where some of these sounds fit. For example, what's the asterisk used for? How about the exclamation point? And which two sounds combine to quit* Windows*? As it stands now, a kitten meows and then a toilet flushes. Worse, we can't sort the* Windows *sounds from the many other sounds used by* Norton Desktop for Windows, *America Online and CD-ROM applications. Help, please! The yak patties are five feet high and rising!*—Marakish, via Internet

A. The problem with upgrading to multimedia status is that you're bound to run across something fun to do, like spending more time than you can afford experimenting with sound effects. I, too, found myself almost transfixed by the unlimited sounds available and their permutations. I hope Table 2 helps you straighten things out. Be aware, though, that this short Table doesn't include sounds added by applications, just those supported by *Windows* 3.1 and *Norton Desktop for Windows*.

DOS User Needs Privacy

Q. *In this day and age of* Windows, *it must seem strange to get a request from a DOS mossback like me. But I need help. My AUTOEXEC.BAT file contains sensitive information I don't want displayed on the screen. I've tried every way I can think of to hide it, including* @echo off, *but nothing seems to work absolutely. Is there any hope?*—Gabby, via America Online

A. My first suggestion is to send each and every command line in the batch file to a null file, as in COPY MYFILE > NUL or DELTREE C:\TEMP /Y > NUL. If this doesn't work, there's a way of totally blinding any screen, but it's a bit risky if you don't know what you're doing. The crux of the operation is to gave over use of the computer from your hands to a dumb terminal using DOS's CTTY command. CTTY redirects the PC's resources to another location, like a serial port. If I were trying this ploy, I'd write an AUTOEXEC.BAT file something like this:

```
ECHO OFF
CLS
CTTY COM2
CALL C:\AUTOFILE.BAT
CTTY CON
```

where AUTOFILE.BAT is your startup file. If your COM2 port is in use, you can use COM1 through COM4, LPT1 through

Table 2. Some Sounds Generated With *Windows* Multimedia

Windows Sound	When it Occurs	Default Sound (*.WAV)
Asterisk	Delete warning, "Are you sure?"	Chord
Critical Stop	An error has occurred.	Chord
Default Beep	Warns when you try to do something out of sequence.	Ding
Exclamation	Warns when you try to copy a file to itself or other illegal destination.	Chord
Question	Announces a dialog box question.	Chord
System Exit	Used by *Norton Desktop* when *Windows* quits to DOS; overrides *Windows* Exit.	Chimes
Windows Exit	Sounds when *Windows* quits to DOS.	Chimes
Windows Start	*Windows* opening sound.	Tada

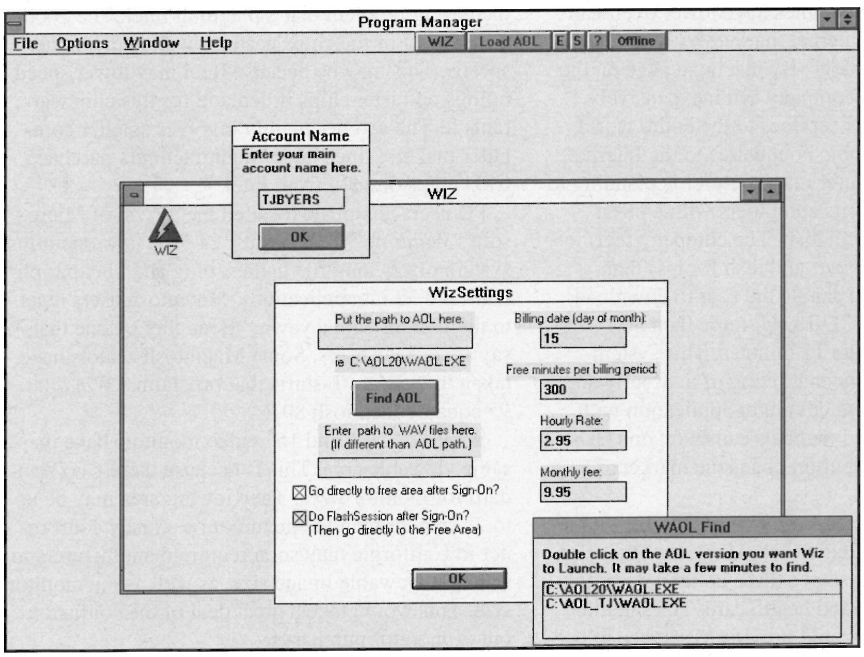
LPT3 or PRN—whichever is available.

The clinker in this scenario is that you need a null-modem loopback device or an active device like a printer connected to the designated port for it to work. While I've tested this batch file, and it works, you have to be careful of routines where you're asked to enter data, like a password or a Yes/No response, because the batch fill will stall and without video feedback you won't know it.

Needs BIOS Upgrade

Q. *I just need a telephone number for Award Software, the company that makes the BIOS chips. Thanks.*—J. Perline, via CompuServe

A. Award Software is located in Mountain View, CA. Its telephone number is 415-968-4433. Readers who are looking for a Phoenix BIOS, contact Micro Firmware at 405-321-8333. Another source of BIOS upgrades is Unicore Software (tel.: 800-800-2467). If the reason you're upgrading your BIOS is to support an EIDE hard disk, I suggest buying an EIDE controller card with an included BIOS, like those from GSI (tel.: 800-486-7800) and Promise Technology (tel.: 800-888-0245). ■



User's Tip: If you need to maximize your America Online time while you minimize on-line charges, try out *Wiz*, an AOL shareware add-on. *Wiz* automatically starts the AOL software, enters your Account Name, gets you on-line and puts you directly into the free areas where you can assemble messages for use in chat sessions. The FlashSession option responds to Instant Messages then immediately pops you back to the free areas, using only a few seconds of paid time. It also lets you send .WAV files to a participant in a chat room. *Wiz* keeps a record of on-line time by free and paid areas and gives you a rolling total of your monthly bill. *Wiz* can be dowloaded from AOL by searching for the keyword Wiz; the filename is WIZ30.EXE.—Ronni Crowe, Dana Point, CA

Industry Watch By John Hastings

The AmCoEx Index of Used Computer Prices

Most computer hardware and software companies have realized substantial gains in the stock market this year. Many stock-market analysts have been predicting a major correction in the industry. While a small correction occurred in August, its effects were short-lived. This seems to baffle the financial community. Most of these analysts have never seen an entire industry rise this fast. Many experts in the computer industry aren't surprised with the technical stocks' performance. They feel this rise is overdue and has a long way to go. The reason for this optimism is synergy. Fast processors, large and inexpensive memory chips and large-capacity hard drives have given computers capabilities no one would have predicted five years ago. In addition, the vast storage capacity of CD-ROMs is just beginning to realize its full potential.

One of the most-profound factors of synergy is improved connectivity. The Internet is just beginning to make its presence known. It's in its infancy. It will develop as much in the next 10 years as computers themselves have in the last 10 years. For example, it will soon revolutionize the way we shop. Just as mail-order companies have lower overhead than local retailers, Internet marketeers won't need to print and mail catalogs. By placing a page on the World Wide Web, a company can inexpensively market its products or services to the entire world. There are no geographic boundaries to the Internet.

At least one computer manufacturer is planning to equip new models of its computers with a pizza sized satellite reception dish. The company feels it can market this computer and dish for less than $3,000. The dish will enable the user to download enough data to fill a CD-ROM, more than 500 megabytes, in less than 12 minutes. This system could revolutionize the marketing of new software and music. The typical computer application with examples, tutorial and manuals can fit on one CD-ROM. Satellite distribution opens the market to a worldwide audience.

These types of systems are expected to be well received in developing countries. Many countries desperately need the assistance these computers could provide in education and health care. The satellite download capability could provide assistance to people in the most-remote areas of the world. As a result, the number of computer users around the world could increase by an order of magnitude.

As more and more of these users become connected to the Internet, the global community will become smaller and better connected. Information will be more difficult for any government to control and democracies will flourish. One offshoot of this trend many people will laud and others will loathe will be the proliferation of English as the universal language.

Notebook computers provide the manufacturers with much larger profit margins than comparable desktop machines. The tooling investment is also much greater. It becomes a high-risk, high-reward game reserved for the big players. For many years, Toshiba was the market leader in this niche. Recently, IBM edged past Toshiba's 23% market share, taking 27% of the market. It has taken this share with high-end, expensive notebook computers. Big Blue hopes to widen this lead this fall with several new low-cost models. By the time you read this, IBM will offer a mix of 486 and Pentium notebooks. Early next year, the lineup will include notebooks based on the newest PowerPC CPU chips. These computers are expected to run *Windows*, OS/2 and Macintosh software at unprecedented speeds.

When is a fast Pentium computer not really a fast Pentium computer? When a slower Pentium CPU chip has been remarked as a faster and more-expensive chip by an unscrupulous distributor. This is an increasing problem that's plaguing Intel. The good news: most of the chips perform well at the higher speeds. This may be because Intel may lower speed ratings on faster chips if demand for this chip warrants it. The activity mainly involves smaller computer makers, since larger manufacturers purchase CPU chips directly from Intel.

PC users anxiously awaited the arrival of Microsoft's *Windows 95* on August 24. The new operating system offers long file names, plug and play peripherals and 32 bit applications. Macintosh users react to the fanfare with a yawn. "Been there, done that," say some Mac users. Some Macintosh zealots have taken to wearing T-shirts that proclaim, "*Windows 95* equals Macintosh 89."

Some 13", 14" and 15" video monitors have the same viewable area. This is because there's no standard for monitor sizes. The viewing area may be up to 2" smaller than the picture tube. A new court order in California may soon require manufacturers to state the viewable image size, as well as the monitor size. This would take a great deal of the confusion out of monitor purchases.

More News

With all of the hoopla over *Windows 95*, everyone understands that Microsoft is big and getting bigger. Although it's the largest software company in the world, it isn't the largest computer company in the world. IBM's revenues are more than ten times that of Microsoft. In fact, in the second quarter of this

year, IBM's profits were greater than Microsoft's sales. IBM seems focused on channeling most of its resources to stop the Microsoft juggernaut. And its resources are formidable.

Not too long ago, the Justice Department would never have permitted IBM to acquire a company the size of Lotus. However, with its current underdog image, that acquisition may just be the first of many. With its lackluster sales of the OS/2 operating system, some people are speculating that IBM may merge with Apple Computer. Since the Macintosh operating system is the second most popular desktop operating system in the world and is compatible with the IBM-developed PowerPC CPU chip, the merger might make sense. While many feel the Macintosh is losing market share, the reality is Apple's sales are at record levels and the company is predicting a 30% growth rate. In fact, sales of the Macintosh are limited only by Apple's ability to manufacture the computers. If IBM put its resources behind this bottleneck, Microsoft's undefeatable image may be somewhat tarnished.

As the Pentium and other 586-generation computers become the standard for today, Intel's next chip is in the wings awaiting debut. Dubbed the P6, the new 686-generation chip is currently being evaluated by several labs. Apparently, the performance of the new systems aren't as good as expected. Intel had implied the new computers would be twice as fast as Pentiums, but early tests are showing a mere 15% improvement.

IBM, Motorola and other chip makers have been claiming that the x86 architecture, known as CISC, was reaching its limits and couldn't go much further. The other chip makers are using a new architecture, known as RISC. Intel has stated its next-generation P7 chip will be a RISC-based device. If the performance of the P6 can't be dramatically improved, Intel may be forced to rush its P7 to market sooner than it had intended. Increased competition from other chip makers won't permit Intel to dictate schedules as it has in the past.

Microsoft has stated that *Windows 95* will never be rewritten for RISC-based computers. It will rely on its *Windows NT* for the newer computers. If the P6 is a short-lived computer, *Windows 95* will be a short-lived operating system. Many users will be irate to find that their transition from *Windows 3.1* to *Windows 95* must be repeated to *Windows NT* after such a short period.

Prices for Used-Computer Equipment as of August 25, 1995

Machine	Average Buyer's Bid	Average Seller's Ask	Close	Change($)
IBM PS/1 486DX2/50, 253M	700	1,150	750	—
IBM PS/2 Model 90, 160M	725	1,100	800	+50
IBM ThinkPad 350C	1,400	1,800	1,475	+25
IBM ThinkPad 700	900	1,500	975	—
IBM ThinkPad 720	1000	1,500	1,100	–25
IBM ThinkPad 755c	2800	3,400	3,100	–150*
AST 486SX/25, 170M	450	850	575	+50
AST 486DX/66, 340M	600	1,000	750	—
AST Pentium 90, 540M	1,400	1,800	1,650	–125*
Dell 486DX/33, 240M	600	1,050	700	+50
Dell Pentium 75, 1G	1,500	2,300	1,800	–150*
Gateway 486/33, 120M	500	700	650	—
Clone 486/25, 120M, VGA	650	1,000	725	+50
Clone 486DX/33, 240M	550	1,000	625	—
Clone Pentium 60, 540M	1,050	1,600	1,300	–100*
Compaq Contura 4/25, 120M	650	1,000	750	–25
Compaq Deskpro 486/33, 120M	650	1,100	700	+25
Mac IIci, 80M	400	850	550	—
Mac Performa 630, 250M	1,000	1,500	1,250	–75*
Mac Quadra 700, 230M	700	1,100	875	+50
Mac Quadra 800, 500M	900	1,500	1,225	—
Mac 7100/80AV, 700M	1,700	2,600	2,250	–100*
Mac 8100/80, 1G	1,950	3,000	2,575	–125*
PowerBook 170, 40M	1,800	1,350	950	—
PowerBook 180, 80M	1,000	1,750	1,350	+25
PowerBook 52,0 250M	1,250	1,600	1,400	–75*
PowerBook 540c, 320M	2100	2,750	2,400	–75*
LaserWriterPro 630	1,100	1,650	1,275	+25
NEC Versa, 340M	1,900	2,600	2,375	–75*
Toshiba 1960CS, 320M	1,400	1,900	1,650	–50*
Toshiba 3200 SXC, 120M	1,700	2650	1850	+50
Toshiba 4800CT, 500M	2,200	2,900	2,600	–75*
HP LaserJet II	350	850	425	—
HP LaserJet IIIP	250	650	325	+25
HP LaserJet III	500	900	550	—
HP LaserJet IV	800	1,200	950	+25

*Denotes new items.

While many people look at the $89 price for the *Windows 95* upgrade as inexpensive, experts warn of the hidden costs. For businesses small and large, the time required for installation and training of *Windows 95* and new applications will amount to more than $1,000 per user. The application upgrades could run between $300 and $500. These upgrades are necessary to take advantage of the new features *Windows 95* provides. The new applications and operating system will then require more memory and hard-drive capacity than most users currently have. The hardware upgrades can run between $1,000 and $2,000.

As many users consider the time and money involved in adding memory and hard drives, not to mention the effort to purchase and install the new *Windows* operating system, the idea of purchasing a new computer with everything pre-installed seems increasingly attractive. This has caused a sudden increase in the number of computers reaching the secondary market. Within six months, this influx of used computers should cause prices to take a precipitous drop. Supplies of slower computers will be increasing while demand wanes. Some slower models will have no value at all. Just as the introduction of the original version of *Windows* marked the death knell of the 286-based computer, *Windows 95* is placing the first nail in the coffin of the 386 and slower 486 computers.

Hewlett-Packard is hoping to accomplish in recordable CD-ROM drives what it accomplished in laser printers. It hopes to make them affordable and sell them by the millions. It may accomplish just this. In November, the HP SureStore was scheduled to be available for just short of $1,000. It will record up to 650 megabytes of data on a CD-ROM at 300K per second and read data from CD-ROMs at 600K per second. While not as fast as Iomega's Zip drives, the new recordable CD-ROM drives are a more economical when storing larger quantities of data.

Prices for Used-Computer Equipment as of September 25, 1995

Machine	Average Buyer's Bid	Average Seller's Ask	Close	Change($)
IBM PS/1 486DX2/50 253M	$500	$900	$650	–$100
IBM PS/2 Model 90 160M	725	1,100	800	—
IBM ThinkPad 350C	1,200	1,700	1,400	–75
IBM ThinkPad 700	800	1,200	900	–75
IBM ThinkPad 720	1,000	1,500	1,125	+25
IBM ThinkPad 755c	2,800	3,400	3,975	–125
AST 486SX/25 170M	450	850	550	–25
AST 486DX/66 340M	600	1,000	700	–50
AST Pentium 90 540M	1,400	1,800	1,525	–125
Dell 486DX/33 240M	1,500	1,050	625	–75
Dell Pentium 75 1G	1,500	2,300	1,675	–125
Gateway 486/33 120M	500	700	650	—
Clone 486/25 120M, VGA	650	1,000	700	–25
Clone 486DX/33 240M	475	900	575	–50
Clone Pentium 60 540M	1,050	1,600	1,225	–75
Compaq Contura 4/25 120M	650	1,000	725	–25
Compaq Deskpro 486/33 120M	650	1,100	800	+100
Mac IIci 80M	400	850	550	—
Mac Performa 630 250M	1,000	1,500	1,125	–125
Mac Quadra 700 230M	700	1,100	875	—
Mac Quadra 800 500M	900	1,500	1,150	–75
Mac 7100/80AV 700M	1,700	2,600	2,050	–200
Mac 8100/80 1G	1,950	3,000	2,350	–175
PowerBook 170 40M	700	1,150	825	–125
PowerBook 180 80M	1,000	1,750	1,175	–175
PowerBook 520 250M	1,250	1,600	1,300	–100
PowerBook 540c 320M	2,100	2,750	2,225	–175
LaserWriterPro 630	1,100	1,650	1,350	+75
NEC Versa 340M	1,900	2,600	2,275	–100
Toshiba 1960CS 320M	1,400	1,900	1,575	–75
Toshiba 3200 SXC, 120M	1,500	2,450	1,725	–125
Toshiba 4800CT 500M	2,200	2,900	2,425	–175
HP LaserJet II	350	800	450	+25
HP LaserJet IIIP	250	650	350	+25
HP LaserJet III	500	900	525	–25
HP LaserJet IV	800	1,200	900	–50

Since 1988, the American Computer Exchange has matched buyers and sellers of used microcomputer equipment. For more information, contact the American Computer Exchange at 800-786-0717 or http://www.crl.com/~amcoex.

In the fast-growing notebook market, Apple has increased its share to more than 20%. The company accomplished this through innovation that almost every other vendor has copied. Apple now hopes to increase its share of this market even further with the introduction in November of its new line of notebooks. The new computers will easily be the most-powerful notebook computers on the market by utilizing a 117-MHz PowerPC CPU chip. With large color screens, large-capacity hard drives and large amounts of RAM memory at affordable prices, the new models will help Apple make greater gains in that market.

Cyrix Corp. has announced that its new M1 CPU chip is faster than Intel's fastest 133-MHz Pentium chip. While pricing hasn't been announced, the new chips should be significantly less expensive than Intel's. M1-based computers should be available by the time you read this.

When most computing was handled on mainframe systems, IBM dominated the industry. It was bigger than all other hardware and software companies combined. With more than 65% market share, its position seemed impenetrable. IBM was able to dictate standards for the industry. If new technology wasn't blessed by IBM, it generally wasn't accepted by the industry, due to the "fud" factor. "Fud" stood for fear, uncertainty and doubt. Many people accused the computer giant of stifling innovation that didn't fit into its plans. However, it was technology that IBM underestimated that led to its fall from the leadership position. First minicomputers and then microcomputers eroded the foundation of the mainframe business and its leader. Ironically, microcomputers didn't receive a welcome reception from most large corporations until IBM put its logo on the PC. The revolution that unleashed was more than IBM could control.

Today, Microsoft is in the leadership position. Some industry experts feel Microsoft may not maintain this position much longer, due to new technology which it can't control. This technology centers around the Internet. Linking computers together will overshadow individual applications. Transmitting voice and video, as well as data, will have profound effects on business and education. One company stands to gain the most from this trend. It owns the Unix software that's the backbone of the Internet. It knows more about networking computers than any other company. This company is Novell. ■

Another way of explaining the code is that when power fails, a test code is stored in RAM. If this code remains the same when power returns, the LED stays lit after the initializing routine (flash on and off). Otherwise, it stays off after this initializing routine. Thus, you can easily test RAM back-up capabilities. Tests indicate that RAM back-up using this method is limited to 3 to 12 seconds, depending on the manner in which power fails (disconnected power source or power failure). If the value of *C1* is increased, longer back-up times can be expected.

Keep in mind that this limited RAM back-up is primarily due to the fact that in Special Bootstrap mode, Magtroll-11 can't make use of super-capacitor *C7* RAM back-up. If an HC11 is used, back-up time increases tremendously because it can be operated in normal single-chip mode and, thus, make use of *C7*'s storage capabilities.

Table 3. Pseudo-Vector Interrupt Assignments

Pseudo-Vector Address (Hex)	Vector Name
00C4-C8	SCI
00C7-C9	SPI
00CA-CC	Pulse Accumulator Input Edge
00CD-CF	Pulse Accumulator Overflow
00D0-D2	Timer Overflow
00D3-D5	Timer Output Compare 5
00D6-D8	Timer Output Compare 4
00D9-DB	Timer Output Compare 3
00DC-DE	Timer Output Compare 2
00DF-E1	Timer Output Compare 1
00E2-E4	Timer Input Capture 3
00E5-E7	Timer Input Capture 2
00E8-EA	Timer Input Capture 1
00EB-ED	Real-Time Interrupt
00EE-F0	IRQ (There is an apparent error here in the first three revisions of the HC11 Reference Manual. The manual lists the address of IRQ as 00EE-FD.)
00F1-F3	XIRQ
00F4-F6	SWI
00F7-F9	Illegal Opcode
00FA-FCCOP Fail	
00FD-FF	Clock Monitor Fail
BF40	Reset (Bootloader Start)

Built-In Safeguards

In many situations, it's important to have some sort of Computer Operating Properly (COP) watchdog system—or at least a convenient separate reset switch. Before I jump into the COP watchdog timer, a few basics are in order. For a microcontroller-operated device to work properly, the program it operates under mustn't have fatal bugs in it. It must be orderly and logical, and it must proceed in an orderly and logical manner. If for some reason the MCU either skips an instruction or, more likely, misinterprets one, the MCU goes wild. The user interprets this as a simple malfunction, perhaps even thinking the MCU board may need to be replaced. The designers of the HC11 included three built-in safeguards to eliminate, or at least reduce this problem. Others can be added, although this is rarely done with the HC11. Let's look at them.

• **COP Watchdog Timer Reset.** Since an enabled COP watchdog system can cause problems unless the software is designed specifically to make use of it, HC11s are shipped with the COP disabled. The COP system is enabled by clearing Bit 2 (NOCOP) of the CONFIG register. It's shipped with this bit set, which disables the COP watchdog system.

If you use MAGPRO-11 described in Part 1 of this series or another system that makes use of the BUFFALO monitor, modifying the CONFIG register is trivial. After you obtain BUFFALO's > prompt, simply type:

```
MM 103F <CR>
```

If you're using an MC68HC11A-1FN, the response will likely be OD. Now simply type 09, hit Enter and then reset MAGPRO-11. Before you do this, make sure you understand how to use the COP. I'll describe only the very basics here. For more details consult Motorola's M68HC11 Reference Manual.

Once the COP system detects a problem, a system reset is automatically generated and the MCU jumps to the start of a program pointed to by the vector located at FFFAH and FFFBH. Keep in mind that although the MCU can differentiate between different reset causes, it's most common to direct all reset vectors to the same initialization software.

The COP detects the problem basically by checking to make sure the software is executed in the proper sequence. It issues a system reset if a predetermined software sequence isn't executed within the COP time-out period. This software sequence is two-step. A write of 55H is made first to the COPRST (103AH) register. Then a write of AAH is made to the same register. Any number of instructions can be performed between these two steps as long as both steps are performed in the correct sequence before the timer times-out. This se-

Table 4. Watchdog Time-Out Periods

Option Register		Crystal Frequency	
Located at 1039H		8 MHz	4MHz
Bit 1	Bit 0	Time-Out Period (ms)	
0	0	16.384	37.768
0	1	65.536	131.07
1	0	262.14	524.29
1	1	1,049	2,100

More Conventions

If you're casually acquainted with the BASIC language, you're probably accustomed to using only decimal (base-10) numbers.

Once you become proficient in BASIC, you'll find that at times it's simplest to use hexadecimal numbers, especially with the DEF SEG statement. In most versions of BASIC, hex numbers are designated with an "&H" prefix. Thus, &HFF stands for the hexadecimal number FF.

Generally, assemblers and cross-assemblers use other conventions for designating hexadecimal numbers. Sadly, these conventions aren't universal. But INTEL designates hexadecimal numbers with an H or h suffix—*not* prefix. For instance, hex number FF is often written as FFH or FFh.

The following discussion pertains to the Motorola's Freeware's IBM PC versions of cross assemblers. Code segments given in this series will operate properly with the as11new.exe cross assembler. Notice that prefixes are used to indicate the base of the number. Hex (base-16) numbers have a $ for a prefix. For example, $F800 is simply the hex number F800. Binary numbers (base-2) are indicated with a % prefix. For example, %11111000 is the binary number 11111000, which is also sometimes written as 11111000B.

You might also see the prefix #, which has nothing to do with the number's base! Rather, it tells the cross-assembler that the coder wants the immediate addressing mode used. For instance, the instruction LDAA #$FF simply means load accumulator A with the hex number FF. These rather odd prefixes are used only in the code. In this discussion, the suffixes H and B are used to indicate hex and binary, respectively.

Listing 3. Setting up the IRQ Pseudo-Vector

(Convention Used: Motorola's Freeware Cross-Assembler)

```
ORG     $B600

LDS     #$00B0
LDAA    #$7E
STAA    $00EE
LDD     #$B700
STD     $00EF
*
*
```

quence of instructions is referred to as servicing the COP timer.

The duration of this time-out period depends on the frequency of the crystal used and Bits 0 and 1 of the OPTION (1039H) register. After coming out of reset with an 8-MHz crystal, time-out is only 16.384 ms (twice as long with a 4-MHz crystal). If both Bit 0 and 1 of the OPTION register are set, the time-out period jumps up to just over a second with an 8-MHz crystal or 2 seconds with a 4-MHz crystal (see Table 4).

• **Clock Monitor Fail Detector.** Since the HC11 was designed for automotive use, Motorola wanted to make it as reliable as possible. A possible solution to a problem like a stuck clock is a Clock Monitor Fail Detector feature implemented in the HC11. This function depends upon CME control Bit 3 of the OPTION register. After reset, this bit is cleared and the clock monitor function is disabled. To enable, it simply set Bit 3 at 1039H. If the MCU detects that the clock has stopped, it generates a system reset and then points to the address located at FFFCH and FFFDH.

In many cases, the low-level on reset, created by the Clock Monitor Fail Detector, corrects the cause of stopped MCU clocks. If the problem isn't corrected, the RESET pin remains low. Also, with suitable added circuitry connected to the MCU's RESET pin, either an alarm can be triggered or a back-up system started or both. One caution is in order. Since the clock-monitor circuit is based on an internal RC time delay and variations exist from lot to lot, any system that operates below 200 kHz should not use the clock-monitor function.

• **Illegal Opcode Trap.** While the designer of the system has the option of using the two watchdog systems mentioned above, you have no choice in use of the illegal opcode trap because it can't be disabled. However, if you ignore it, you can have problems. When an opcode or, more commonly, an opcode sequence is encountered that doesn't make sense to the CPU, a true nonmaskable interrupt is requested to the illegal opcode vector.

Never leave this illegal opcode vector initialized. Also, the vector should point to a code segment that immediately re-initializes the stack pointer. One simple way of accomplishing this is to simply place the same address in the Illegal Opcode Vector as is in the RESET vector—at the start of the program. I like the illegal Opcode trap because it's simple to use and nearly foolproof. In addition, it usually solves what would otherwise be a wild program syndrome.

Tips on Setting Bits

The HCx11 has a number of registers in which bits control various aspects of its characteristics. This is one feature that accounts for its versatility. To set or clear a single bit at a memory location, all you need do is store the appropriate number at the register. For instance, say you want to turn on the Clock Monitor function. You must set Bit 3 at the OPTION register located at 1039H. The following code segment will accomplish this:

```
        *
        *
LDAA        #%00001000
STAA        $1039
        *
        *
```

You may notice a problem here. If you didn't, think about the other bits in the OPTION register. Most have an important function and your program segment just cleared all of them! There are two solutions to this. First let's look at an example that uses only 6800-compatible instructions to set Bit 3 at 1039H:

```
        *
        *
LDAA        $1039
ORAA        #%00001000
STAA        $1039H
        *
        *
```

To clear Bit 3 use:

```
        *
        *
LDAA        $1039
```

```
ANDA     #%11110111
STAA     $1039
     *
     *
```

If you wish to use the extended opcodes provided to HC11 users, the following code segment will set Bit 3 of 1039H:

```
     *
     *
LDX      #$1039
BSET     0,X,%00001000
     *
     *
```

Then the following code segment will clear this same bit:

```
     *
     *
LDX      #$1039
BCLR     0,X,%00001000
     *
     *
```

Be careful because the code is no longer downward-compatible. BSET and BCLR are new opcodes with the HC11 and HC04. They aren't legal for 6801/6803, 6802/6808 and earlier MCUs.

Tips On Using MC68HC11s

If you plan on installing an MC68-HC811E2FN in Magtroll, you'll likely want to operate the MCU in normal single-chip mode. This is accomplished by jumpering *JP3* and pins 1 and 2 of *JP5*. When the MCU is in normal single-chip mode, the software design is straightforward.

All normal interrupt vector assignments are used (Table 1). For instance, the all-important RESET vector is located at FFFEH and FFFFH, just as for the 6803, 6808, 6802 and even the original 6800. Thus, the address of the start of your program should be placed here. Your program will typically start at F800H. So place F8H at FFFEH and 00H at FFFFH. Also, place this same address at the Illegal Opcode Trap vector at FFF8H and FFF9H. Unless you're experienced, don't use either of the COP watchdog systems.

Make absolutely certain that one of the first instructions is to initialize the stack pointer. Typically, this can be accomplished with the single instruction LDS #$00FF.

Things are slightly more complicated when using the MC68HC11A1FN in Magtroll-11. This assumes you're going to use the MCU's internal EEPROM for the system's sole firmware source. The primary attributes of the A1FN that make it slightly more complicated to use are the EEPROM's location in memory, the fact that it can't be moved in memory and its small size. It's also possible to use Magtroll-11 in an expanded system, which I'll cover shortly.

To use a Magtroll-11 with an A1FN in a single-chip system, the MCU must be first placed in Special Bootstrap mode by placing a jumper at JP3 and another between pins 2 and 3 of JP5. To cause an immediate jump to beginning of the EEPROM located at B600H, also place a jumper at JP2.

Notice in Table 2 that the normal

Listing 4. Test of XIRQ/STOP Back-Up

(Convention Used: BUFFALO)

```
B600  LDS   #B0
B603  CLRA
B604  TAP
B605  STAA  F3
B607  STAA  1000
B60A  LDAA  #7E
B60C  STAA  F1
B60E  LDAA  #B7
B610  STAA  F2
B612  JSR   B650
B615  LDAA  #10
B617  STAA  1000
B61A  JSR   B650
B61D  CLRA
B61E  STAA  1000
B621  JSR   B650
B624  LDAA  #10
B626  STAA  1000
B629  LDAA  #10
B62B  MPA   #6F
B62D  BNE   B633
B62F  CLRA
B630  STAA  1000
B633  WAI
......
......
B650  LDX   #FFFE
B653  NOP
B654  NOP
B655  NOP
B656  DEX
B657  BNE   B653
B659  RTS
.....
.....
B700  LDAA  #6F
B702  STAA  10
B704  NOP
B705  STOP
B706  RTI
```

Listing 5. Cross-Assembler Code Segment

```
    ORG        B600H
* REM: First load the stack pointer with 00B0H
    LDS        #$00B0
* REM: Then store the opcode for JMP statement at F7H
    LDAA       #$7E
    STAA       $F7
* REM: Finally, set up pseudo-vectors
    LDD        #$B600
    STD        $F8
             *
             *
* REM: place rest of program here
```

reset vector, located at FFFEH and FFFFH no longer is valid. Rather, the reset vector is located at BF40H, which is the start of the bootloader program. In one sense, this simplifies things. However, if you're accustomed to designing programs for the 6800 or its offspring, it can become confusing.

As the previous discussion indicates, if JP2 is jumpered, the bootloader program causes an immediate jump to the start of the program at B600H. Also initialize the stack pointer, only this time, have the top of the stack start at 00B0H instead of 00FFH. And initialize the Illegal Opcode Trap pseudo-vector at locations 00F7H, 00F8H and 00F9H. The cross-assembler code segment given in Listing 5 accomplishes this.

Expanded Multiplex System

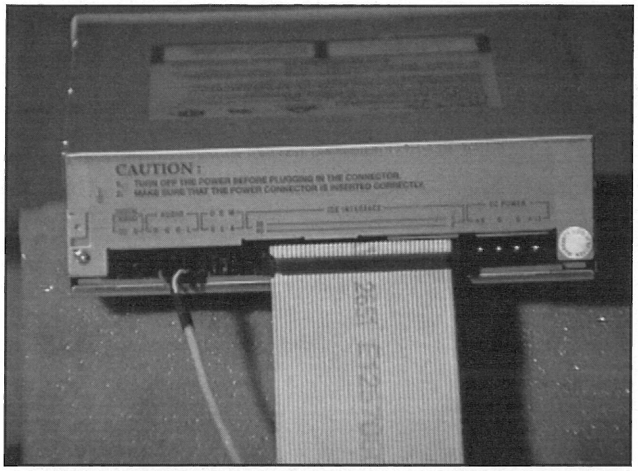
Though Magtroll-11 was designed to be used in single-chip systems, it's adaptable for use in expanded multiplex systems, with firmware located in an external EPROM. Notice in Fig. 2 that a 74HC373 octal transparent latch is required for de-multiplexing. To set up the MCU for normal expanded multiplex operation, place jumper pins 1 and 2 of JP5 but do *not* install a jumper at JP3. Make sure you've initialized the reset vector at FFFEH and FFFFH (place the starting address of your program in these memory locations).

Now that you know the basics of Magtroll-11, you can do something practical with it. This is the subject of Part 3 in this series. To make things more interesting, I'll look at a unique wind-direction indicator that requires no moving parts. It uses all the intelligence that can be packed into a 512-byte program. This project, along with a few general hints, should provide enough information for you to start building your own widely differing projects around Magtroll-11.

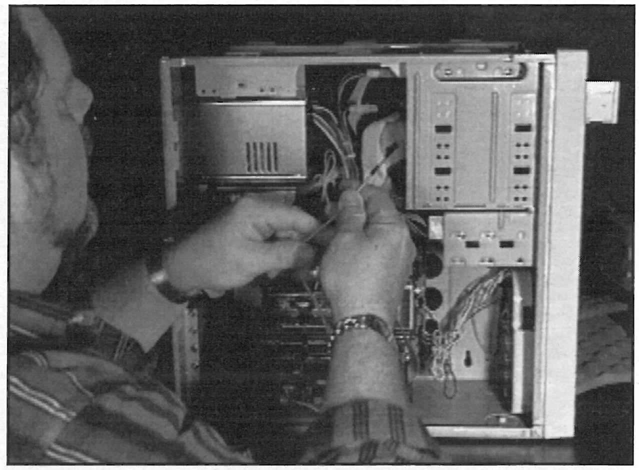
Other Companies Mentioned

Digi-Key Corp.
701 Brooks Ave. S.
PO Box 677
Thief River Falls, MN 56701-0677
Tel.: 1-800-344-4539

Mouser Electronics
National Circulation Center
2401 Hwy. 287 N.
Mansfield, TX 76063-4827
Tel.: 1-800-346-6873



The CD-ROM interface ribbon and audio cables are shown attached to the drive because I couldn't get a clear shot of them once the drive was installed in the PC.



The audio cable from the SoundBlaster 16 should be attached to the CD-ROM drive first, since the connector is located farthest to the left.

about getting the best recording, playback and music/sound effects, these are definitely the cards of choice.

If you're an aural connoisseur and your pockets are deep enough, you might want to consider one of the very-high-end sound cards that give extended music and MIDI synthesis capabilities and a plethora of recording compression options. Cards like the Turtle Beach MultiSound, Tahiti and Maui and the Antex Z1 (with the ZWave 32-voice Ensoniq daughterboard option) typify the high-end, professional-caliber cards that feature 24 (or more) voice multitimbral music capabilities, 16-bit stereo recording at 44.1 kHz (Redbook Standard CD Audio) and variable-ratio compression options, in addition to wavetable, digital sampling and impressive mixing/processing capabilities. Though cards of this caliber will set you back $600 and more, if sound really turns you on, they'll do it for you.

• **Audio Input/Output Items.** You'll need speakers or/and headphones to handle the audio output of your multimedia setup. So add these items to your shopping list.

Many sound cards come with a decent microphone as standard and usually have a "Y" adapter cable that has a miniature stereo phone jack at one end and dual phono jacks at the other end for routing sound to a stereo amplifier. If these aren't included with the sound card you have or buy, you must purchase them separately.

Decent lightweight personal-stereo-type headphones provide listening to your sound card's output without disturbing others, while un-amplified speakers (also the type typically used with a personal stereo) are generally all you need for adequate sound reproduction at room volume levels. If your system is in a noisy environment, or if you just like to crank up the volume, consider purchasing good amplified speakers like Labtec's CS-150 series (about $20 to $25).

Path 1: Upgrade Kit Route

Several major manufacturers offer upgrade kits that generally consist of a CD-ROM drive, sound card with integrated drive interface, setup and driver software, cables to connect all the components, documentation and some niceties like a microphone, patch cables, speakers and/or headphones and a multimedia CD-ROM bundle. These kits are usually available in configurations that feature internal or external CD-ROM drives.

With the market changing so rapidly, manufacturers are constantly changing their upgrade-kit offerings. So the best advice I can give is to check out what's available at your local computer retail outlet to obtain the latest prices and specifications on upgrade kits from major well-known manufacturers. To give you an idea of what a typical upgrade kit installation is like, I'll use the Creative Labs Discovery CD 4× Plug N Play kit as an example. Here's what's involved in performing the installation:

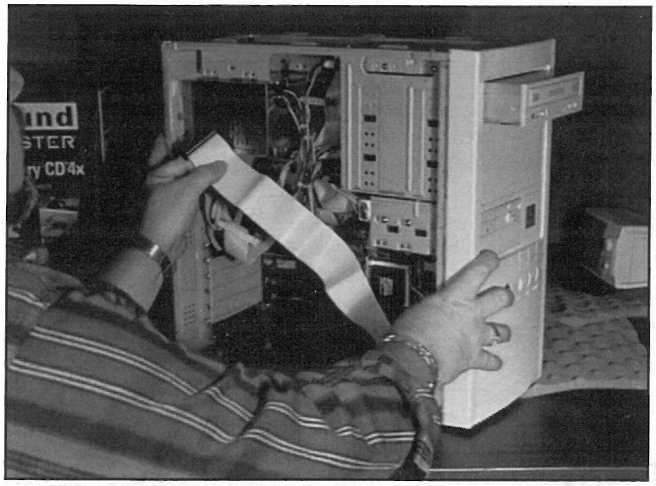
• **Step 1.** Disconnect the power, video-monitor, keyboard, mouse, printer and any other cables from your PC and place the system unit on a sturdy surface with good lighting so you can work on it comfortably.

• **Step 2.** Remove the cover of the system unit. Select a convenient slot for the Creative Labs SoundBlaster 16 card. You need a 16-bit slot that can accommodate the 3/4-length card and that will be easy to access from the rear of the PC for connecting the speakers, microphone, etc.

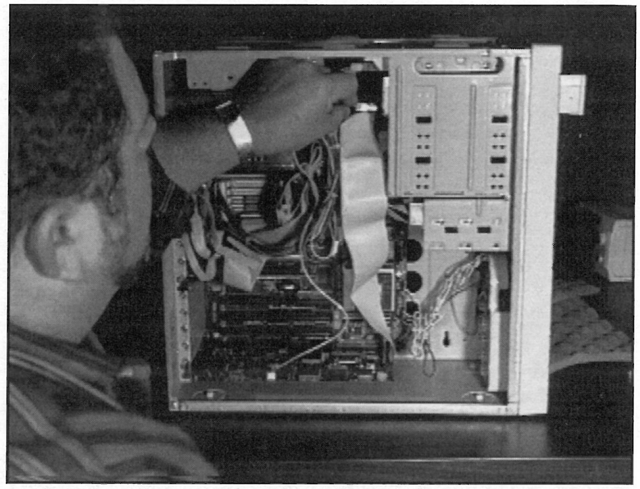
• **Step 3.** Attach the supplied ribbon cable to the IDE interface connector on the SoundBlaster card, being careful to orient it properly on the header. The ribbon cable has a colored tracer on the end that denotes the pin-1 location. Failure to orient the cable properly will prevent the drive from working.

• **Step 4.** An audio cable is also supplied with the Creative Labs upgrade kit. Each end of the cable terminates in a different connector that mates to card and CD-ROM drive, respectively, so that there's no way you can make a wrong connection. Slide the cable connector onto the end connector on the SoundBlaster card. It's much easier (and advisable) to attach the cables to the card prior to plugging the card into the slot on your PC's motherboard.

• **Step 5.** Plug the SoundBlaster card in the expansion slot you've chosen, pressing it into place with firm, even pressure using your thumbs until you feel it bottom out. Replace the screw



Next, the IDE interface ribbon cable attaches to the drivet. With pin 1 located on the right side of the drive closest to the power connector, the tracer on the ribbon cable should be facing you as you install it on the drive. Be careful not to bend any pins, and make sure you seat the cable all the way into the connector.



Plug a pigtail connector from the PC's power supply into the power connector socket of the CD-ROM drive, which is on the extreme right of the drive. This connector is keyed so that it can't be plugged in backward.

that previously held the blocking plate for the slot to secure the card in place.
• **Step 6.** Remove the blocking plate that conceals the drive bay you want to use for the CD-ROM drive, and slide the drive into the bay.
• **Step 7.** Attach the required cables to the drive. For easiest installation, plug the audio cable into the drive first, followed by the ribbon interface cable (pay special attention to proper orientation) and, finally, the pigtail connector from the PC's power supply.
• **Step 8.** With all cables attached, secure the drive in the bay using the supplied screws. Replace the cover on your PC's system-unit enclosure and secure it in place with the screws you previously removed.
• **Step 9.** Now make the I/O connections. Attach the amplified speakers that come with the Creative Labs kit to the speaker output connector on the SoundBlaster 16's backplane and plug in a microphone or line-input device, if you wish.
• **Step 10.** Reattaching the keyboard, mouse, power, monitor and any other cables you removed prior to installation concludes the hardware procedures. All you have left to do is to install the supplied software to be up and ready for multimedia operation.

Path 2: Off-the-Shelf Systems

Without doubt, the least-painful way to get into multimedia is to buy a completely configured multimedia computer system from one of the better manufacturers. These systems are usually "ready to roll" as soon as you take them out of the box, connect everything together and apply power. Everything you need—CD-ROM drive, sound card/interface and software—is already installed and loaded, just waiting to be fired up and used.

As with upgrade kits, it's virtually impossible to give a current listing of what constitutes the best value in a ready-to-run multimedia system. The reason is that each manufacturer is unveiling or releasing something new on what seems to be a weekly basis.

Manufacturers like Radio Shack (Tandy), Packard Bell, Dell, AST, Swan, Compaq, IBM, NEC and others are all offering high-performance, Pentium-based multimedia PC systems that are complete with amplified speakers, video monitor and multimedia CD-ROM software libraries. In virtually all cases, these systems have all the software already installed and set up on their hard drives. You can also purchase a PC system without any multimedia options (CD-ROM drive, sound card or speakers) and add the components of your choice.

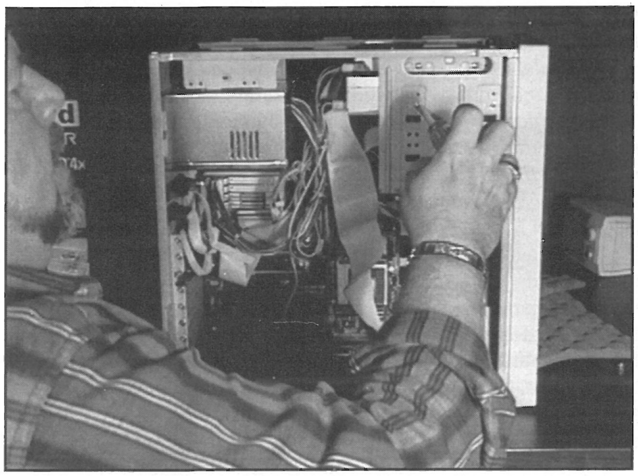
As an alternative, you might want to purchase a system that's partially outfitted for multimedia, such as the MicroExpress MicroFLEX-586 system used for my upgrade project example. This system comes standard with a Cyrix 586 CPU that has performance comparable to a 75-MHz Pentium, PCI bus architecture, 16M of RAM, a 15" video monitor and an internal double-speed CD-ROM drive. You just add a sound card and speakers to obtain MPC Level 2 multimedia capability.

Path 3: Built it Yourself

Some folks, I among them, have particular wants and/or needs that simply can't be filled by off-the-shelf items or factory configurations. If this sounds like you and you aren't afraid to usea screwdriver and have a bit of experience working inside computer cases, this may be the approach for you. A few cautionary words are in order, however.

If you don't have good overall knowledge of computer components and don't feel comfortable working with static-sensitive devices (or have an innate fear of things electronic), don't build a system yourself. Buy one instead and save yourself lots of grief and frustration. However, if you're a stalwart soul, let me offer some sage advice.

(1) ***Don't be penny-wise and dollar-foolish.*** Generally, a better grade component, though slightly more expensive, is a much greater value in the long run in terms of dependability and long-



Use the four screws supplied in the Creative Labs kit to secure the drive into the bay. When you're certain all cable connections are correct and secure, replace the cover on the PC's system-unit enclosure.

The Creative Labs Discovery 4× multimedia upgrade kit comes with a pair of amplified speakers that attach to the sound card's external-speaker jack via a miniature stereo phone plug. The jack is located closest to the MIDI/joystick D-shell connector. Adjacent to the speaker jack are line and microphone inputs.

term performance. This is especially true of motherboards. Since the motherboard is the heart of a computer, don't skimp by buying some no-name import one with an unknown BIOS. My personal choice is a premium-grade motherboard from American companies like Mylex, American Megatrends, Micronics and Vega, to name a few. Construction and the components used on these boards is clearly superior to any of the bargain-basement imported boards.

(2) ***Think of tomorrow's needs today.*** Computer technology changes so rapidly that its mandatory you think of what you'll want to expand or upgrade to in the near future. So bear this in mind when putting together your system today. Look for a motherboard that permits CPU upgrading.

Select a motherboard and system-unit enclosure that have ample expansion slots. Make sure the power supply is powerful enough to handle all the goodies you'll be stuffing into the box (200 watts minimum).

(3) ***Go for better-grade peripherals.*** Again, don't be miserly or you'll be less than delighted with the outcome. When selecting a CD-ROM drive, choose a fast model with high transfer rates and low access times, rather than a middle-of-the-road drive just because it comes with a lot of bundled software. The same is true for a sound card. Get one that's going to do all you require of it now and for the foreseeable future.

(4) ***Shop around.*** First decide on the components you want to use in your system. Then shop around to obtain the best pricing on the exact items you want, since technical support probably isn't going to be a big deal to you if you're putting it all together yourself. Mail-order electronics supply houses may have the best prices, as opposed to traditional local computer retailers.

Here's the configuration of a system that I put together myself. The core is a 120-MHz Pentium CPU on a motherboard with PCI and ISA slots, AMI BIOS, 32M of RAM, one each 3½" and 5¼" floppy-disk drives, 540M IDE hard drive C, 1.2G IDE hard drive D, 540M IDE hard drive E, 128M SCSI magnetic/optical drive F, NEC MultiSpin 6× SCSI CD-ROM drive G, Pinnacle RCD-202 Recordable CD-ROM drive H and an SCSI Sony 2G DAT tape back-up drive.

For audio, I use an ESS Stereo Magician 16-bit audio card, but I also have a Yamaha CBX-T3 General MIDI tone generator connected to it, and I use a pair of Audio-Technica ATUS MMS 557 active two-way multimedia speakers for output. For video capture, I use the Intel Smart Video Recorder Pro card, and my system's SVGA video adapter is a Stealth PCI Viper 64 with 2M of DRAM. Video display is handled by a ViewSonic 7 17" SVGA monitor. I input using a Microsoft Natural Keyboard and Microsoft mouse.

By the time you read this, I'll most likely have upgraded to faster Pentium-based motherboard—maybe even a P6, if it's available, and probably an MPEG1 and/or Wavelet video codec card. I'm also thinking of putting in a PCMCIA slot drive to interchange peripherals with my NEC Ultralite Versa E DX4/75 color notebook PC.

To accommodate these additions I'll have to go to a full-size tower enclosure for the required additional bay and slots.

There's a lot more to the hardware and software of multimedia than I can hope to cover in a single article. What I've written here is a good point from which to start. If you want to take it all a few steps further, I recommend that you get copies of my three books: *Welcome To...CD-ROM, Welcome To...PC Sound, Music and MIDI, Introducing Desktop Video*). Each deals in-depth with specific aspects of multimedia. You can order them directly from me. I'll be happy to personally inscribe each book for you. Prices include shipping and handling. See the Products Mentioned box at the end of this article.

Just remember as you seek multimedia Nirvana that, though the end of the path may not be in sight, it's the journey that provides the enlightenment.

Product Reviews

For the example installation in this multimedia upgrade how-to, I used the Creative Labs SoundBlaster Discovery CD 4× Multimedia Upgrade Kit and Micro Express MicroFLEX-586 Computer System. Here's more information on each of these fine products.

SoundBlaster Discovery CD 4x Multimedia Kit

Creative Labs released its $400 Discovery CD 4× Multimedia Upgrade Kit about mid-year in 1995. Now the company offers a Plug and Play version for those people who have *Windows 95* or system BIOS extensions that support Plug and Play peripherals.

At the heart of the kit is a 16-bit stereo SoundBlaster 16 sound card with SoundBlaster software provided for both *Windows 95* and *Windows* 3.1. An internal quad-speed IDE CD-ROM drive, utility installation software and stereo speakers are also provided, as are an IDE ribbon interface cable and CD audio output cable.

The kit includes Creative's standard setting hardware and 3D stereo-enhancement technology that provides a richer, more-realistic effect. By enhancing the stereo image of sounds coming from dual speakers, a more-spacious sound is produced that adds depth and spatial "presence" to the audio tracks of multimedia titles. SoundBlaster 16 is also upgradeable with the WaveBlaster II daughterboard for adding EMU8000 wavetable synthesis with true instrument sounds.

Creative's quad-speed internal CD-ROM drive utilizes IDE interfacing for increased performance. With a front-loading tray mechanism, disc caddies aren't required. The drive provides a 600K/s transfer rate, with 250-ms average access time. As you'd expect, the drive is multi-session Photo-CD-capable and delivers excellent performance.

I was somewhat surprised that no microphone or line-input patch cables were provided. A pair of good-quality amplified stereo speakers are provided, though.

To get you off to a flying start enjoying multimedia as soon as installation is done, an excellent assortment of CD-ROM software is supplied: *Full Throttle* and *Star Wars Dark Forces Special Edition* from LucasArts Entertainment; *Cyberia Mission Norway, Descent Destination Saturn* and *Virtual Pool Straight/8* from Interplay; *Unnecessary Roughness '95* from Accolade; *Heretic, Episode 1* from Id Software; *Pinball Dreams Deluxe* from 21st Century Entertainment; *Grolier Multimedia Encyclopedia* from Grolier Electronic Publishing; *Freddi Fish and the Case of the Missing Kelp Seeds, Putt-Putt Joins the Parade, Putt-Putt and Fatty Bears Activity Pack* and *Let's Explore The Farm* from Humongous Entertainment; *My First Incredible, Amazing Dictionary* from DK Multimedia; and *Nickelodeon Director's Lab* from Viacom New Media (specially enhanced for optimum performance on SoundBlaster audio cards).

Creative Labs has done an outstanding job of putting together a great quad-speed drive, genuine SoundBlaster 16 sound card, speakers and software in an easy-to-install and -love package that costs less than some quad-speed drives alone.

Micro Express Micro-FLEX 586 PC

The first Cyrix 586-based PCs have made their debut under the Micro Express banner, bearing the designation of Micro-FLEX-586. Two models are offered, one in a PCI version, the other in a VL local-bus version. I worked with the PCI version in preparing this multimedia upgrade feature and was pleasantly surprised with the overall quality of components, construction and performance.

MicroFLEX-586 systems come with a 15" video monitor, 16M of RAM, 256K of RAM cache, Microsoft mouse, 101-key keyboard, very-fast 850M hard drive and a double-speed CD-ROM drive. Micro Express lets you choose to have *Windows 95* or DOS 6.22/*Windows* 3.11 pre-loaded on the system.

Right out of the box, all you have to install is a sound card and you're multimedia-capable. For purposes of my how-to example in the main article, however, I removed the 2× Sony IDE drive that came with the computer and installed the Creative Labs unit instead.

The MicroFLEX-586 PCI version includes the Phoenix Plug and Play Flash BIOS that permits automatic configuration of all Plug and Play add-in cards, including the SoundBlaster Discovery 4× system with seamless *Windows 95* compatibility. Literally, all you have to do is install the hardware, and *Windows 95* does the rest, automatically scanning and detecting the sound card and CD-ROM drive, modifying the system to work with both. The VL version of the MicroFLEX-586 uses an AMI Flash BIOS but doesn't support Plug and Play features.

My review unit came with a lightning-fast ATI Mach 64 PCI video card and had *Windows 95* already loaded. A *Windows 95* CD-ROM was also supplied for backup purposes, as were floppy diskettes containing the ATI video drives and Sony CD-ROM drive's device driver.

Supplied documentation included the ATI video card user's guide, MicroFLEX user's manual, motherboard booklet and "Introducing Microsoft Windows 95" user's guide. The 15" SVGA video monitor also had a basic user's manual supplied with it.

For an additional $25 each, *PFS: Windows Works* Version 2 and *PFS: Publisher for Windows* can be bundled with the system. If you need these software applications, this, too, is another great deal.

Since Micro Express claims that its

100-MHz Cyrix 586 CPU has performance comparable to an Intel 75-MHz Pentium, I decided to run a basic series of benchmarks to check out this claim. Using the System Information program from the *Norton Utilities*, I ran the benchmark suite on three systems using genuine Intel Pentiums running at 100, 75 and 60 MHz, along with the MicroFLEX-586. While just a tad slower than the Swan Pentium 75-MHz system, the MicroFLEX-586 was light-years faster than the NEC Pentium 60, and it had the fastest hard drive of any of the systems tested.

MicroFLEX-586 ships in a mini-tower system unit that has provisions for three accessible $5\frac{1}{4}$" drives, on accessible $3\frac{1}{2}$" drive, two internal $3\frac{1}{2}$" drives and one internal $5\frac{1}{4}$" drive. Consequently, there's plenty of room for adding storage devices. The proprietary PCI motherboard has three PCI and four 16-bit ISA expansion slots. A maximum of 128M of RAM is supported on both versions of the motherboard.

If you're looking for a way to obtain Pentium performance, a 15" video monitor, more than 800M of hard-drive storage, 16M of RAM, fast PCI video and a double-speed CD-ROM drive at a very attractive price, check out the MicroFLEX-586. With the money you save, you can treat yourself to a really nice sound card and a good sampling of CD-ROM titles to use on your new system. ■

Norton Navigates Stormy *Windows 95* Waters

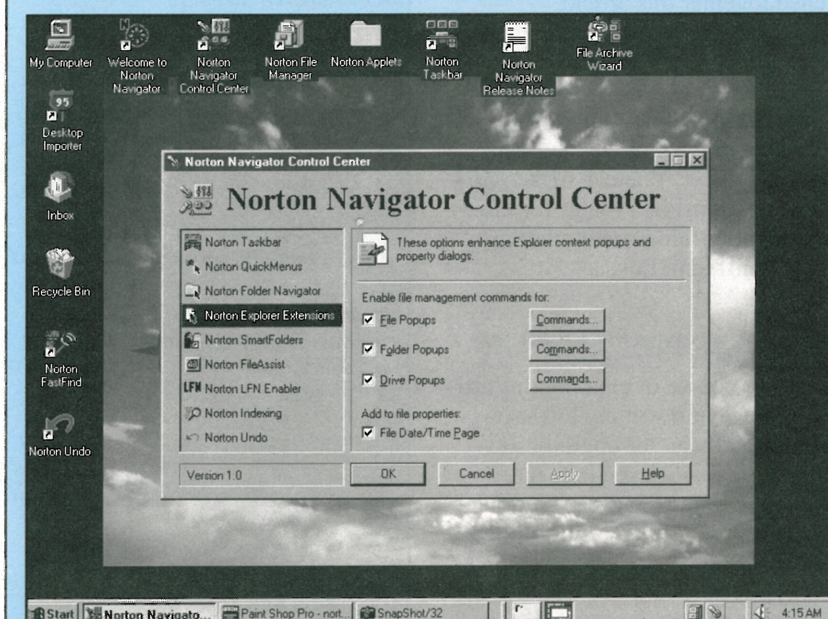
If *Windows 95*'s Explorer lacks your favorite file-manager features, check out *Norton Navigator* from Symantec. This heavily-laden file-management program draws its utilities from several sources, including *Norton Desktop, Norton Commander, PC Tools* and *Xtree*. It builds on the best features of these products and adds new features designed specifically for *Windows 95*.

The focal point is File Manager, a powerful, customizable desktop with the look and feel of a *Norton Desktop for Windows* custom screen. In fact, if you already have a custom *Norton Desktop for Windows* desktop, *Norton Navigator* will automatically port it over to *Windows 95* for you. Like its predecessor, you can use wild cards to filter, copy, rename and move files, and clicking the right mouse button brings up a related pop-up menu.

Other features include a file sorter that lets you re-order the ways the files are displayed and a file viewer. To open or view a file, you don't even have to know or enter its full name. Simply start typing its name, and chances are good *Navigator* will find and highlight it for you. There's a search function that can locate lost files via text strings. Navigator also offers encryption, undelete capabilities and *PKZip* compression.

If you don't like the *Navigator*'s File Manager but do like it's enhanced features, you don't have to use it. *Navigator* places most of its enhancements, like file compression and encryption, into *Windows 95*'s own menus. My only complaint is that you have no choice as to which utilities you want to install and which to skip. It's all or nothing; so be prepared to have plenty of hard-disk space available.

Norton Navigator, $99
Symantec Corp.
10201 Torree Ave.
Cupertino, CA 95014-2132
Tel.: 800-441-7234
CIRCLE NO. 120 ON FREE INFORMATION CARD



called "Start" that does double duty to launch applications and shut down your system. Clicking on Start opens a menu that basically lists all the *Windows 95* operations. Clicking on an operation generally opens other menus, like the Programs menu seen in Fig. 2. At the bottom of the screen is the Taskbar, which contains graphic representations of the open applications. To maximize one of these applications, you simply click on its icon.

Unlike the case with *Windows* 3.1, the *Windows 95* desktop isn't carved in stone. For example, you can move the Taskbar from top to bottom or side to side. You can also create new My Computer desktops for other users and create Shortcut folders.

Folders

The Start button is a hotkey way of doing things. First, you click on the

Start button, drag the highlight bar to a menu choice, move the highlight bar sideways (left or right, depending on the direction in which the drop-down menu appears), choose an option again, and—hopefully—find what you're looking for or continue to expand menus. Fortunately, there are better ways to launch a program or open a file. They include folders, shortcuts and the Explorer.

Looking very much like a Macintosh screen, the *Windows 95* screen setup often makes use of folders to guide you through the labyrinth of hard-drive directories. Basically, a folder is a collection of applications, programs, files and other flotsam and jetsam.

Although you can use a folder for anything you wish to file under a common cover, it's most effective when you use it for a project. For example, I used a folder to hold all my text and screen shots for this article, along with icons for the *Norton Navigator* and *Windows* tutorials that stitched together this article.

Files and programs in a folder are automatically linked together, regardless of where they may exist on your hard drive. Moreover, the links are folder-specific in that they exist for only that project. You can make photocopies of items in a folder for insertion into other folders and other projects with different links.

Shortcuts Not Startup

During the course of creating this article, I often shut down my PC to install new hardware or upgrade software. This doesn't even take into account the times I had to shut down and restart my PC as a result of the software crashes that occurred along the way. Because a lot of what I created depends heavily on graphics, I found it much too time-consuming to constantly re-install the screen-capture and graphics view programs from Start after each shut-down or crash. So I created a Shortcut folder.

Basically, shortcuts are an extension of the icons found in the Program Manager groups in *Windows* 3.1. Using a simple drag-and-drop routine, shortcut icons are easily copied from the Start menu or other folders. Launching a shortcut application is as easy as opening the folder from the desktop and double-clicking on the icon.

Shortcut establishes all the necessary links. You can even place files in a shortcut folder, like a word-processing document, and shortcut will open the application and load the specified file. Unfortunately, you have to do this manually each time you boot *Windows 95* because *Win95* doesn't have an equivalent of the Startup group in *Windows* 3.1 that automatically loads these programs when you power up your system.

Exploring Explorer

If you're a long-time DOS user, the path C:\WRITE\MAIL\JUNE makes sense to you. Many newcomers to the PC world, though, feel thoroughly confused and frustrated by DOS's path requirement that must be typed in letter-perfect down to punctuation. *Windows* 3.1 attempted to put things in order by offering a File Manager. Unfortunately, this proved to be merely a Band-Aid device that created as many problems as it solved. This is why many *Windows* users migrated to *Norton Desktop for Windows*. In *Windows 95*, the file manager is called Explorer (Fig. 3).

While Explorer is better than the file manager in *Windows* 3.1 and certainly a breath of fresh air, it also demonstrates why there will always be a market for third-party *Windows* add-ons like the *Norton Navigator*. A lot of what's wrong with *Windows*

Where To Buy

Learn To Do Windows 95 With John C. Dvorak, $39.95
Allegro New Media
16 Passaic Ave., Unit 6
Fairfield, NJ 07004
Tel.: 800-424-1992

CIRCLE NO. 121 ON FREE INFORMATION CARD

EasyTutor Learn Windows 95, $40
CRT Multimedia, Ltd.
Tel.: 214-386-3600

CIRCLE NO. 122 ON FREE INFORMATION CARD

The Improv Presents Windows 95 *For The Technically Challenged*, $39
Graphic Zone
42 Corporate Park #200
Irvine, CA 92714
Tel.: 800-828-3838

CIRCLE NO. 123 ON FREE INFORMATION CARD

Professor Windows 95 *Deluxe CD*, $29.95
Individual Software
5870 Stoneridge Dr. #1
Pleasanton, CA 94588-9900
Tel.: 800-822-3522

CIRCLE NO. 124 ON FREE INFORMATION CARD

Introduction to Windows 95, $29.95 ($39.90 With Manual)
Learnkey. Inc.
1845 W. Sunset Blvd.
St. George, UT 84770
Tel.: 800-865-0165

CIRCLE NO. 153 ON FREE INFORMATION CARD

How & Why Windows 95, $19.95
Microsoft Press
One Microsoft Way
Redmond, WA 98052
Tel.: 800-677-7377

CIRCLE NO. 126 ON FREE INFORMATION CARD

Personal Training for Windows 95, $29.95
Personal Training Systems
Macmillan Computer Publishing
173 Jefferson Dr.
Menlo Park, CA 94025
Tel.: 800-832-2499

CIRCLE NO. 127 ON FREE INFORMATION CARD

Class Act, $99.95
Soft One
1121 South Orem Blvd.
Orem, UT 84058
Tel.: 800-235-3276

CIRCLE NO. 128 ON FREE INFORMATION CARD

WinTutor 95, $7.95
SoftKey Int'l.
PO Box 629000
El Dorado Hills, CA 95762
Tel.: 800-845-8692

CIRCLE NO.129 ON FREE INFORMATION CARD

Learning Windows 95, *Introduction*, $49.95 ($89.95 for Introduction and Advanced)
ViaGrafix
5 South Vann St.
Pryor, OK 74361
Tel.: 800-842-4723

CIRCLE NO. 130 ON FREE INFORMATION CARD

3.1's file manager spills over to Explorer.

Explorer does have some redeeming qualities. For example, you can view the files as folders, short names or detailed names with file size and date stamp. Moreover, *Windows 95* can support and display filenames of up to 255 characters in length and lets you mix upper- and lower-case with inserted spaces. For example, "My Favorite File" is a legal *Windows 95* filename.

Opening Documents

Another way to launch an application is to simply click on a document from the Start prompt. Doing so not only starts the application to which the document is attached—be it *Excel*, *Lotus 1-2-3* or *Word for Windows*—*Windows 95* continues to load the file or document and puts it on-screen. Cool. But you can do this in *Windows* 3.1, too, if you know how to drag and drop a file from File Manager. *Windows 95* just makes it easier.

The only problem with all the longcut and shortcut options mentioned above is that they can get overwhelming. For example, when is it faster to load a program from Start/Run, as opposed to Start/Programs, or is Start/Documents the fastest path? Given time, maybe you can sort things out and determine which method works best for you. I personally like the Startup group in *Windows* 3.1 because it's a no-brainer.

If I decide to live with *Windows 95*—which is highly likely, despite the fact I have to upgrade about 50% of my software—I guess I'll start stuffing my Shortcut folder with... well, shortcuts. Maybe *Norton Navigator* will fill this void in its next release.

Compatibility

Though *Windows 95* claims backward-compatibility for DOS and *Windows* 3.1 software, this is really stretching the point. Some software is compatible, and some isn't.

I don't claim that I have the latest versions of every program in stock. For example, my mainstay screen-capture program is *Tiffany*, a shareware program I acquired in 1991 and love a lot. You've seen the results of its use a lot in my column and articles. However, *Tiffany* refuses to load or run under *Windows 95*. So, I went searching and found only one screen-capture program that actually works with *Windows 95*. It's a shareware program called *Scan30* that's available only on AOL, as far as I know.

Screen capture isn't the only compatibility problem you'll encounter when upgrading to *Windows 95*. As a rule, most Microsoft applications will work, and most others are a 50% hit-or-miss proposition. Ironically, *Word for Windows* 2 won't run. Why anybody would be using *WinWord* 2 today is beyond me, but it seems it's file format is a staple in the Macintosh world, which is used to lay out what you're now reading. All my manuscript submissions are done in *WinWord* 6 format and translated into *WinWord* 2 format for processing by the art department, which means either I or my editor, a very patient guy, has to do the translation and read through all the errors. In *Windows 95*, this translation is all but impossible.

I can go on forever about *Windows 95*'s compatibility problems, but I won't simply because I think *Windows 95* was shrink-wrapped at the very last minute (what a revelation). As you'll see upon reading the "Learning Windows 95" box, I found that half the tutorials have problems with text display, missing subjects or inaccuracies. In some cases, it's the fault of the tutorial program. Too often, though, it's because *Windows 95* was an operating system in development, which made it a moving target for the vendors who were trying to write programs for it. In fact, the next time you see *Windows 95* (my guess is four months from now), Microsoft will be selling it as *Windows 96* and asking you to cough up extra bucks to upgrade. It's no wonder Bill Gates is the second-richest man in the world.

Buy Now Or Wait?

Windows 95 is almost bulletproof. Compared to the many operating systems I've reviewed over the years, it's the most solid. The problem is that too many *Windows* 3.1 users panic when something appears to go awry and bail out when all they have to do is hit the Ctrl+Esc key combination to resolve the problem. On the other hand, I know how to recover from many—but not all—*Windows 95* disasters. So I guess I fall in the above group, too.

The Bottom Line

I can't really put my finger on who should and shouldn't buy *Windows 95*. If you didn't understand everything I discussed in this article, you're a likely candidate for *Windows 95*. It'll hold your hand and quietly suck you into the Microsoft world—on-line network and all. Just have a lot of plastic or hard cash in hand. However, if you're happy with your *Windows* 3.1 system and can't afford to buy the Pentium PC of your dreams, I'd wait for *Windows 96*. ■

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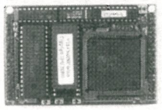

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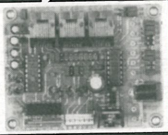

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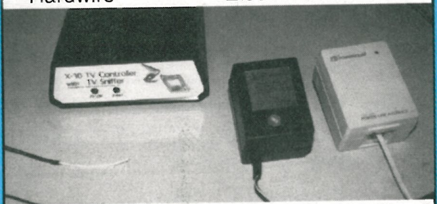

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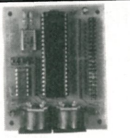

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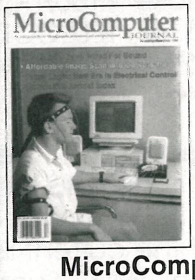

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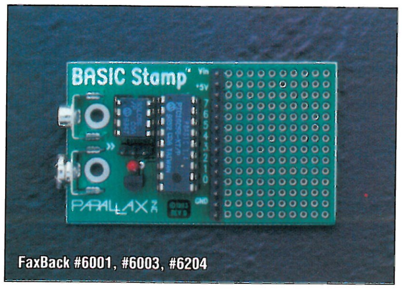

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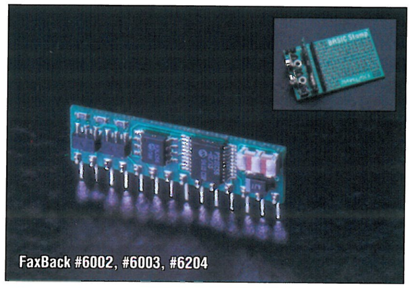

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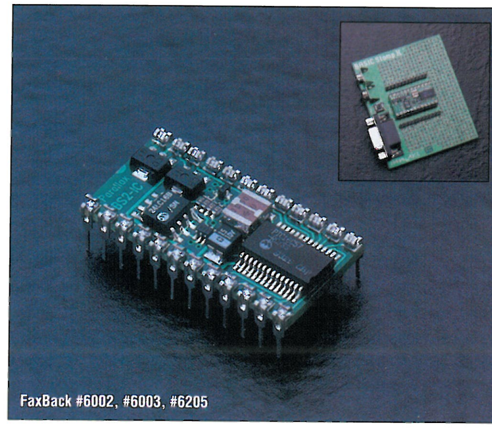

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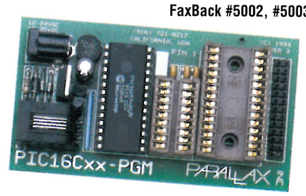

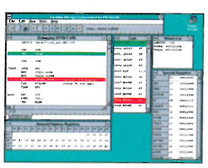

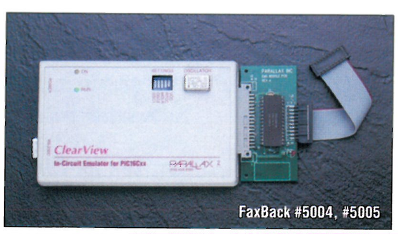

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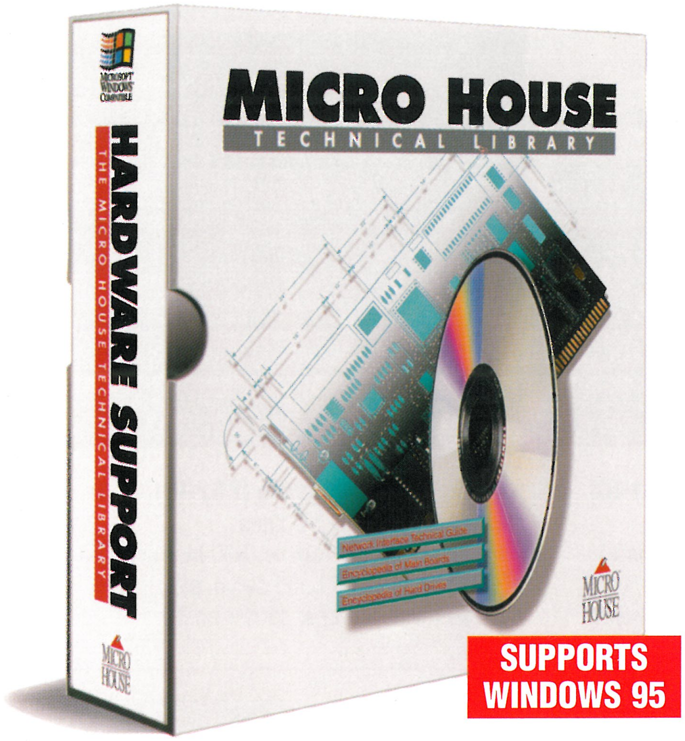

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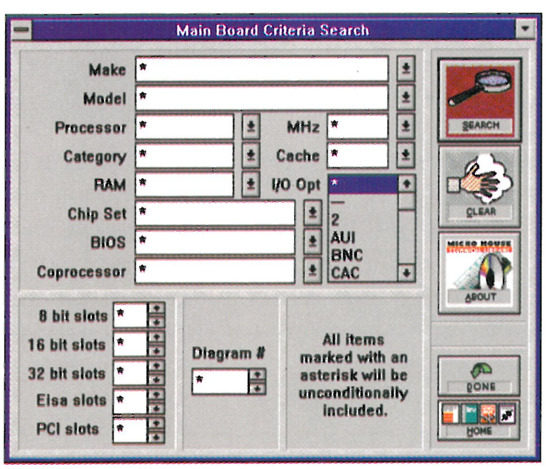

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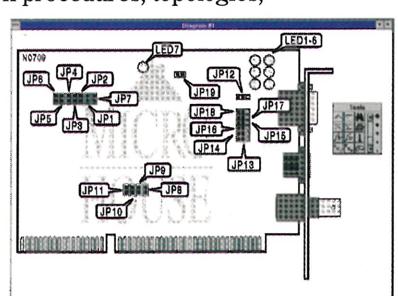

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